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THE PROGRESSIVE FISH-CULTURIST

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SPOT-POISONING APPLIED TO THE MASSACHUSETTS LAKE AND POND FISHERIES SURVEY

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AMONG THE FIRST to practice routine sampling of fish populations by spot-poisoning with rotenone were Eschmeyer and coworkers in the impounded waters of the Tennessee River and its tributaries (Chance and Miller 1952). Original objectives included collection of materials for growth studies, quick indices of population status, and trends from year to year. Only recently have fishery investigators begun to apply this technique elsewhere to any extent. One factor retarding adoption has been a belief that serious public repercussions were inevitable in areas less remote than TVA's impounded waters. The reliability of the method (compared to seining) has been doubted both quantitatively and qualitatively. Apparently many biologists have believed that the poisoning only of large areas (i.e., several acres) would produce tangible results. There has been the further thought, too, that this procedure can neither be justified nor reconciled with the public in congested regions characterized by relatively small waters. The specter of prolonged toxicity has had its discouraging effects as well.

FACTORS PROMPTING INTRODUCTION OF SPOT-POISONING

Conduct of the Massachusetts Lake and Pond Survey came under the direction of the writer in 1951. By then the Division of Fisheries and Game was under justifiable pressure to accelerate the survey. A number of ways were found to accomplish this and to increase the efficiency of the survey at the same time. These included substitution of echo sounding for handline sounding (Stroud and Grice 1952) and spot-poisoning with rotenone for seining. Massachusetts' public fishing waters number about 450 units and average only 85 acres in surface area (excluding one exceptionally large reservoir of about 25,000 acres). They are further characterized by high transparencies, considerable amounts of aquatic vegetation, rocks, rubble, trash, and irregular bottoms. Consequently, they are relatively small waters and, as with TVA waters, can be seined only with great difficulty or not at all. While a substantial amount of labor was formerly expended seining at each pond, results in quantity, sizes, and species of fish caught were generally inadequate. In short, assessments of spawning success among various species and collection of species too wary or too small for capture in gill nets--major objects of seining--were most difficult and often impossible.

These facts, and familiarity with the rotenone sampling technique as initially employed at TVA, prompted the writer to substitute spot-poisoning for seining in Massachusetts. Consequently, the fish populations of 96 ponds were sampled with rotenone in 1951. Seining was conducted concurrently in 23 of these 96 ponds. (A few more ponds were surveyed where seining was employed instead of spot-poisoning for a variety of reasons.) Results show that spot-poisoning can be used successfully in relatively small ponds, in densely populated areas, with increased validity and reliability over seining. This was demonstrated both by a general lack of public hostility and by various findings presented below.

TECHNIQUE OF SPOT-POISONING

As described by Chance and Miller (1952), spot-poisoning in TVA reservoirs is conducted

Credit is due Dr. Britton C. McCabe and Thomas Andrews, leaders of the 1951 pond survey crew, for field work performed under the writer's direction and supervision to provide the data. Reported under Federal Aid in Fish and Wildlife Restoration--Mass. Proj. No. F-3-R. September 15, 1951.

at a cove site carefully selected for its physical characteristics. The sampling bays have maximum depth normally less than 30 feet, usually between 10 and 20 feet, depending upon the nature of the reservoir area under study. (In the writer's experience, such a cove comprised several acres and was generally longer than wide with a more or less constricted mouth.) Powdered derris root is prepared and employed in sufficient quantity to render the water excessively toxic to fish. No stop net is used to prevent movement of fish into or out of the study area. Under TVA conditions, possible extensive fish kills outside the poison area are generally no cause for great concern. Areas chosen are sufficiently remote to minimize problems of public relations that might otherwise arise.

Small cove sites best: Certain modifications were desirable in Massachusetts. First, dimensions of the sample area were substantially reduced. In practice it was quickly found that coves much less than 0.5 acre in surface area gave relatively poor results--with a few notable exceptions--in terms of quantity, kinds, and sizes of fishes taken. It is believed that unavoidable commotion involved in approaching either smaller areas or open shoreline areas scared away many of the larger game fish. With the latter possibility in mind, the optimum size area appeared to approximate 0.75 acre. This cannot be substantiated statistically.

Selection of coves for sampling sites resulted in about 2.4 times (by weight) as much fish being sampled as from straight shoreline sites. Shoreline sites were spot-poisoned in 28 ponds while coves were treated in 68 ponds. The areas averaged the same (0.5 acre) in each situation. The average weight of fish recovered per acre was 13.3 pounds for open shoreline sites and 32.2 pounds for cove sites. Use of areas much larger than 0.75 acre tended to overtax the capacity of the survey crews to collect and utilize the fish in the time allotted (about 4 hours). Too, it generally provided more fish than are actually believed necessary to fulfill objectives (assessment of reproduction, availability of forage, presence and relative abundance of hard-to-take species, and pond balance). The size of sampling areas chosen ranged from 0.1 to 1.5 acres and averaged 0.5 acre. Maximum depths of sampling areas rarely exceeded 6 feet but ranged occasionally to 10 feet.

Stop net believed essential: As another modification, a small-mesh seine of sufficient length and depth to prevent movement of fish either into or out of the selected cove was employed as a stop net. In a very few cases the seine was a few feet too short or too shallow to span the cove entrance completely. It is believed that close observations and heavy dosages of rotenone maintained at these points, however, served effectively to prevent any substantial escapement of fish in such cases. A 12-thread small-mesh seine 200 feet long by 8 feet deep has been adopted as the most suitable stop net for spot-poisoning of cove sites in Massachusetts waters. It is possible that use of a similar net about 600 feet long would permit effective spot-poisoning of shoreline sites as well, although this was not employed here. It was hoped that use of the stop net would render the findings quantitatively comparable among ponds. In any case, general observations indicated that many adult chain pickerel, yellow perch, and largemouth black bass attempted to leave the sampling areas, following application of the rotenone, but were stopped and retained by the stop net. Most such fleeing fish would doubtless have been lost had not the stop net been present. No doubt, need for such a net is in some degree inversely proportionate to the size of the sampling area.

Dilution below toxic levels rapid: The amount of rotenone-bearing agent needed to achieve a concentration of 0.025 p.p.m. of rotenone was carefully measured to minimize possible sustained killing power outside the immediate area selected for sampling. As a rule, dilution followed quickly and effectively so that successful reinvasion of the area by live fishes was possible by evening of the same day (when the stop net was removed) or--at the latest--by the following day. There were two occasions where the toxic water retained its identity sufficiently to kill portions of fish populations in adjacent coves during the night. Ordinarily, it appears, mixing induced by wind action is sufficiently rapid to limit most kills to the immediate area treated with the quantities of rotenone and water volumes involved.

The rotenone to be used is diluted with water and applied between net and shore, usually from a boat. Emulsifiable forms of rotenone were found most convenient to use in the small quantities employed at each pond. The possible need of using the same preparations in all operations has been suggested by Chance and Miller (1952). Emulsifiable rotenone was used here in every case. A 5-gallon hand pump is used to spray the surface, starting first near the stop net and working toward shore. The entire surface area is treated more or less uniformly in most coves, but more heavily over the deeper water of some coves and at any possible escape points. In any event,

with summer water temperatures ranging from 70° to 85° F., fish begin to die within a few minutes following application of the rotenone. Pick-up of the dead and dying fish commences immediately. Since maximum depths of treated areas are limited to about 8 feet, average depths are invariably less than 3 feet. The entire volume of water, through the normal settling of the rotenone, is quickly rendered toxic. Water currents induced by wind action commence working immediately to mix and then dilute the treated water effectively below toxic levels for fish within a few hours (within 4 to 6 hours in most cases). The work is facilitated and containment of toxicity is aided by an inshore breeze. Coves to be treated are selected partly with this in mind. In the two cases of kills in adjacent coves, the wind was blowing offshore. This resulted in immediate drift of toxic surface waters to the adjacent areas.

COMPARISON OF SAMPLING WITH SEINES AND WITH ROTENONE

Effective sampling of certain species--especially largemouth black bass--has long been a problem. Crowe (1950) has recently described a small trap net said to be effective for sampling largemouths. Much recent interest has also arisen over possible advantages of nylon gill nets for improved sampling of wary species. Spot-poisoning with rotenone tends to solve this problem in large measure.

Former sampling methods inadequate: Using gill nets and seines as sampling tools, McCabe (1948) failed to sample black crappie[1/] in 9 ponds; smallmouth black bass and brown bullheads in 3 ponds each; largemouth black bass, bluegills, and pumpkinseeds in 2 ponds each; and yellow perch and chain pickerel in 1 pond each from among 12 Massachusetts ponds for which he had creel records indicating their occurrence in some abundance.

Angling reports have generally suggested for some time that both largemouth black bass and black crappie are more abundant than either their frequency ratings or their total numbers in fish collections of past surveys would indicate. This is borne out by comparing fishes collected from 53 central Massachusetts lakes and ponds sampled with gill nets and seines in 1944 and 1945 (McCabe 1948) with those from 52 lakes and ponds in the same region that were sampled with gill nets and rotenone in 1951 (unpublished data). Although the two groups of lakes and ponds are not identical, they lie closely interspersed throughout the same region, are subject to closely similar climatic and geologic influences, and are actually connected in many instances. Since they appear to be closely comparable as groups, it seems valid to compare these fish collections (table 1).

Frequency ratings of several species differ markedly in the collections made by these two methods. Pumpkinseeds, bluegills, golden shiners, largemouth black bass, black crappie, johnny darters, brown trout, and madtoms were all collected relatively more frequently in 1951. Consequently, other species--chain pickerel, smallmouth black bass, yellow bullheads, fallfish, and rainbow trout--were displaced to varying extents of lowered rating. Among these, however, chain pickerel and fallfish were secured from an increased number of ponds in 1951. Seven species that were not collected at all (1944-45) when seines were employed--redfin pickerel, eastern brook trout, banded sunfish, yellowbellies, bridled shiner, spot-tail shiner, and common shiner--were added to the central Massachusetts fish distributional list (1951) when rotenone was used. It should also be noted (table 1) that the number of fish collected per pond in 1951 averaged substantially higher as well. While this is partly due to improved methods of fishing gill nets, a portion of this increase is attributed to use of rotenone. This is particularly apparent for largemouth black bass, chain pickerel, pumpkinseeds, bluegills, yellow perch, white perch, black crappie, brown bullheads, and golden shiner. Thus where many of these species of fish might have appeared scarce or where their reproductive success may have been questioned in 1944-45, their relatively greater abundance and generally successful reproduction is revealed by the 1951 collections.

It may probably be assumed, in actuality, that chain pickerel, yellow perch, and brown bullheads (perhaps golden shiners as well) occur in nearly every body of water in Massachusetts regardless of whether survey collections include them.

Spot-poisoning and seining in identical ponds: There were 23 ponds surveyed in 1951 where both conventional seining and spot-poisoning were conducted. These provide data for a direct comparison of these two methods within identical ponds at the same time (table 2). Again spot-poisoning gives the more accurate assessment of the presence of certain species and of their reproduction. Seining

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[1/] Names of fishes are those adopted by the American Fisheries Society (see Report of the Committee on Common and Scientific Names of Fishes, published as Spec. Pub. 1, American Fisheries Society, 1948).

TABLE 1.--Frequency rating of fishes for central Massachusetts, based on the number of lakes, ponds, and reservoirs where they were collected by means of seines and gill nets in 1944-45 (53 lakes and ponds), and rotenone and gill nets in 1951 (52 lakes and ponds)[1/]

Species collected	Number of times (ponds) collected		Number of fish collected (Average per pond in parentheses)		Frequency rating	
	1944-45	1951	1944-45	1951	1944-45	1951
Pumpkinseeds	30	47	1,071 (35.7)	2,565 (54.6)	5	1
Yellow perch	43	45	1,361 (31.7)	1,216 (27.0)	1	2
Chain pickerel	42	45	209 (5.0)	924 (20.5)	2	2
Brown bullheads	31	43	323 (10.4)	713 (16.6)	4	3
Bluegills	32	40	909 (28.4)	4,890 (122.3)	3	4
Golden shiner	21	39	319 (15.2)	2,085 (53.5)	7	5
White perch	29	37	561 (19.3)	1,326 (35.8)	6	6
Largemouth black bass	16	29	76 (4.8)	625 (21.6)	8	7
Black crappie	11	20	79 (7.2)	199 (99.5)	10	8
White sucker	15	15	33 (2.2)	127 (8.5)	9	9
Bridled shiner	0	10	0 (0.0)	331 (33.1)	-	10
Chubsucker	10	10	42 (4.2)	116 (11.6)	11	10
Smallmouth black bass	16	9	106 (6.6)	33 (3.7)	8	11
Johnny darter	1	8	2 (2.0)	24 (3.0)	16	12
Yellow bullheads	8	6	90 (11.3)	281 (46.8)	12	13
Brown trout	4	6	6 (1.5)	10 (1.7)	14	13
Fallfish	3	5	13 (4.3)	51 (10.2)	15	14
Banded sunfish	0	5	0 (0.0)	20 (4.0)	-	14
Killifish	3	4	260 (86.7)	85 (21.3)	15	15
Madtoms	1	2	8 (8.0)	592 (296.0)	16	16
Channel catfish	1	2	1 (1.0)	4 (2.0)	16	16
Spot-tail shiner	0	1	0 (0.0)	180 (180.0)	-	17
Rainbow trout	6	1	8 (1.3)	4 (4.0)	13	17
Yellowbellies	3	1	11 (3.7)	2 (2.0)	15	17
Eastern brook trout	0	1	0 (0.0)	1 (1.0)	-	17
Common shiner	0	1	0 (0.0)	1 (1.0)	-	17
Yellow pikeperch	1	0	2 (2.0)	0 (0.0)	16	-
Totals	22 species	27 species	5,491 (103.6)	16,407 (315.5)		

[1/] Frequency ratings for 1944-45 collections differ slightly from those given by McCabe (1948: 104) because of deletion of angler catch records, included by McCabe, in order to make these data comparable to 1951 data.

TABLE 2.--Fish collections made by seining and by spot-poisoning concurrently in 23 identical lakes, ponds, and reservoirs in 1951

Species collected	Number of times collected		Number of fish collected (Average per pond in parentheses)		Frequency rating	
	With seines	With rotenone	With seines	With rotenone	With seines	With rotenone
Chain pickerel	11	21	28 (2.5)	150 (7.1)	4	1
Bluegills	17	20	486 (28.6)	1,572 (78.6)	1	2
Yellow perch	16	20	1,028 (64.3)	407 (20.4)	2	2
Pumpkinseeds	14	19	369 (26.4)	368 (19.4)	3	3
Largemouth black bass	5	14	17 (3.4)	156 (11.1)	5	4
Brown bullhead	2	14	44 (22.0)	89 (44.5)	7	4
Golden shiner	5	11	104 (20.8)	444 (40.4)	5	5
Johnny darter	1	5	4 (4.0)	47 (9.2)	8	6
Bridled shiner	0	4	0 (0.0)	211 (52.8)	-	7
Redfin pickerel	0	4	0 (0.0)	18 (4.5)	-	7
Black crappie	2	4	22 (11.0)	17 (8.5)	7	7
White perch	5	4	62 (12.4)	11 (2.2)	5	7
White sucker	4	3	77 (19.3)	31 (10.0)	6	8
Smallmouth black bass	2	2	2 (1.0)	3 (1.5)	7	9
Alewife	0	1	0 (0.0)	38 (38.0)	-	10
Killifish	2	1	3 (1.5)	10 (10.0)	7	10
Yellowbellies	1	1	3 (3.0)	2 (2.0)	8	10
Chubsucker	0	1	0 (0.0)	1 (1.0)	-	10
Brown trout	1	1	1 (1.0)	1 (1.0)	8	10
Common shiner	0	1	0 (0.0)	1 (1.0)	-	10
Banded sunfish	0	1	0 (0.0)	3 (3.0)	-	10
Carp	1	0	1 (1.0)	0 (0.0)	8	-
Totals	16 species	21 species	2,251 (97.9)	3,580 (155.7)		

failed altogether to collect certain species--redfin pickerel, banded sunfish, bridled shiner, alewife, chubsucker, and the common shiner--although their presence was revealed with rotenone. This was true in four separate instances each for redfin pickerel and bridled shiner. Hard-to-take species achieved higher frequency ratings from spot-poisoning than from seining. These included chain pickerel, largemouth black bass, brown bullhead, and johnny darter. Smallmouth black bass, brown trout, bluegills, white perch, killifish, and white suckers, on the other hand, received lower frequency ratings in rotenone samples than in the seines. This is very misleading, since only the last three species were sampled in fewer ponds. The fact that the average number of largemouth black bass and chain pickerel--important predators--taken per pond is greatly increased through spot-poisoning, is of added significance. Seining, where attempted, appeared to be biased by its selective tendencies for yellow perch and white perch. Frequency ratings alone fail to reveal the full advantage of spot-poisoning for collecting certain species. For example, largemouth black bass attained frequency ratings of 4 in these 23 waters from spot-poisoning and of 5 from seining. While this indicates greater frequency of occurrence, largemouths were actually collected in 61 percent of the ponds by spot-poisoning but in only 22 percent by seining. This is nearly a threefold increase in efficiency with rotenone! While less than half as many yellow perch were collected with rotenone as with seines, spot-poisoning revealed the presence of these fish in 25 percent more ponds. Brown bullheads were collected from 7 times as many ponds; johnny darters from 5 times as many ponds; golden shiners, chain pickerel, and black crappie from about twice as many; and pumpkinseeds and bluegills from about 36 percent and 18 percent more ponds, respectively, by spot-poisoning as by seining. White perch, white suckers, and killifish, however, were sampled in fewer ponds with rotenone. Carp, found in one pond with seines, were not found during spot-poisoning.

As previously stated, a major objective of either seining or spot-poisoning is assessment of reproduction among various species. This obviously requires that the method employed collect small-sized fish in quantity. Again this requirement is better met when reliance is placed on rotenone (table 3). A greater percentage of all fish taken were less than 6 inches total length when so sampled. This was particularly evident among chain pickerel, white perch, brown bullheads, and golden shiners, and somewhat less so among largemouth and smallmouth black basses, and yellow perch. No difference in size distribution occurred among black crappies, pumpkinseeds, bluegills, and white suckers.

THE QUESTION OF POPULATION BALANCE

Straight minnow seines are widely employed for analyzing farm pondfish populations in the South (Swingle 1945). The efficacy of this equipment has been challenged for Indiana Ponds (Krumholz 1951), where it was believed necessary to employ bag seines instead. It was shown for some Indiana farm ponds that certain species could not be taken in the ordinary straight minnow seine. Both types of seines have failed rather miserably in the natural and impounded waters of Massachusetts. Properly constructed and fertilized farm ponds

TABLE 3.--Representation by size of fishes taken with rotenone and with seines in 106 Massachusetts ponds surveyed in the summer of 1951

Species	Percent of average collections by sizes and total number of fish collected							
	Rotenone samples (96 ponds)				Seining samples (37 ponds)			
	0 to 5.9 inches	6.0 to 11.9 inches	12.0 + inches	Total number fish	0 to 5.9 inches	6.0 to 11.9 inches	12.0 + inches	Total number fish
Chain pickerel	74	22	4	1,848	26	67	7	54
White perch	85	15	-	39	22	78	-	103
Brown bullhead	95	5	-	1,229	51	49	-	154
Golden shiners	97	3	-	5,498	75	25	-	197
Largemouth black bass	86	11	3	1,019	75	22	4	51
Smallmouth black bass	81	19	-	41	73	9	18	11
Yellow perch	84	16	-	3,608	78	16	3	1,424
Black crappie	87	13	-	483	85	15	-	46
Pumpkinseeds	97	3	-	4,150	96	4	-	926
Bluegills	94	6	-	7,012	95	5	-	973
White sucker	87	9	4	54	88	10	3	120
Simple average or total	88	11	1	24,981	69	27	3	4,059

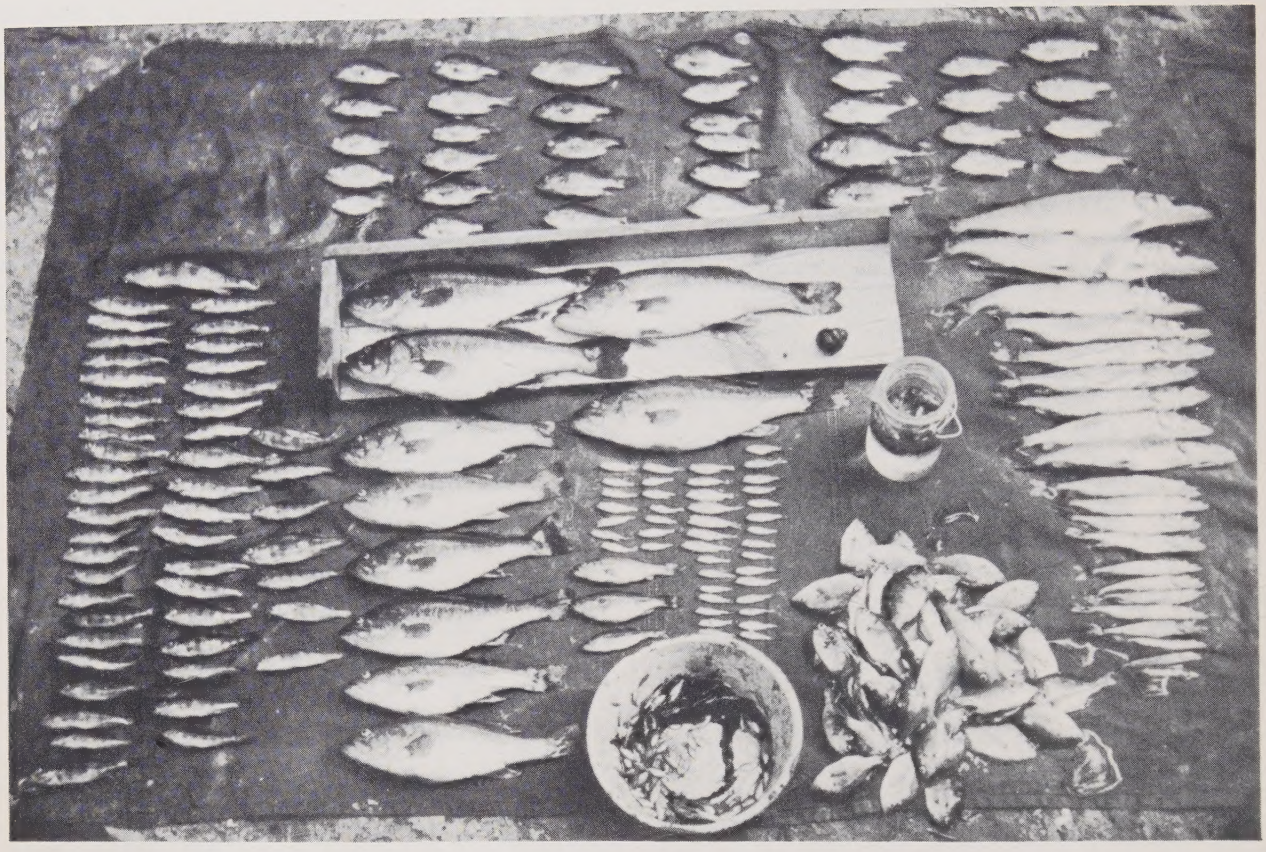

FIGURE 1.--Composition of partial yield of a 1-acre cove at Ponkapoag Pond, Canton, Massachusetts, August 1951. Pumpkinseeds at top, yellow perch at left, largemouth black bass at center, chain pickerel at right center, bluegills at lower right, bluegills and brown bullheads in pan. Measuring board is 30 inches long.

have little aquatic vegetation and few other obstacles to seining in the way of rubble or rocks, bottom irregularities, or trash. Just the opposite tends to be true in natural and impounded lakes and ponds of many States--including Massachusetts.

This condition imposes a serious handicap upon the seining method of analyzing pond balance. As shown above, it is only rarely that enough young game and pan fishes can be taken with seines to indicate how successful reproduction may be. Similarly, many species are not sampled at all. The suggested selectivity of seining in these waters and the lack of a satisfactory quantitative seining unit virtually preclude the possibility of calculating any of the quantitative measures of balance recently suggested by Swingle (1950). Data from summertime spot-poisoning, to the contrary, permit limited assessment of population from all these standpoints. Caution must obviously be employed in view of such unassessed factors as spatial variations in fish distribution, time of day or night, conformation of pond basins, efficiency of fish pick-up following poisoning, etc.

Effective pick-up is particularly important and may be decreased by poor visibility due to turbidity, extent of vegetation, and other factors. The largest recovery among the 96 ponds spot-poisoned in 1951 was 70.1 pounds per acre (excluding one pond with sea-run alewives where 147.5 pounds per acre were recovered, mostly of this species). By comparison, best current estimates of average fish carrying capacity of Massachusetts ponds (unpublished data) indicate average standing populations of 100 or more pounds of fish per acre. It is well known that centrarchid fishes are available for capture in a fresh condition only briefly during poisoning operations. They sink to the bottom quickly after being affected by rotenone. This renders their initial collection difficult in deep or turbid waters. All species are readily recovered from the bottom in the relatively

clear shallow waters characteristic of Massachusetts. Limited recovery of certain species would undoubtedly constitute an important bias in areas of dense aquatic vegetation, in waters of low transparency, or in deep sampling sites. Occasionally, some species--either as young or adult--avoid shoal water entirely or may invade it only at night. In Massachusetts this is fairly characteristic of the white perch as a species and of golden shiners as adults and must be taken into account where these species occur. It is believed that variable spatial distribution constitutes the biggest source of bias in the data when used for quantitative estimates of pond balance.

Fish sampling data for Ponkapoag Pond, Canton (Norfolk County), afford an example of utilization of such data. Here spot-poisoning of a 1-acre cove in August (1951) yielded 43.3 pounds of fish. By weight, about 56 percent were predators, while the remainder were pan fish (table 4, figure 1). The supplementary catch of gill nets set overnight here was 28.0 pounds and consisted of 38 percent predators, 28 percent pan fish, and 24 percent weed fish (table 5). Sixty percent of all fish taken were game and pan species over 0.25 pound each. This pond was considered to be in balance (Stroud, in press). All species were reproducing adequately, the predator ratio was high, and the availability of harvestable sizes good. Growth rates of yellow perch and bluegills were somewhat depressed (unpublished data), although better than in most ponds.

Corresponding data for Winneconnet Pond, Norton (Bristol County), on the other hand, indicated a condition of unbalance. Spot-poisoning of a 0.5-acre cove yielded 27.5 pounds of fish (table 4). Of this total, 5 percent were predators, 12 percent were weed species, and 82 percent were pan fish. The gill net sample (table 5) weighed 67.0 pounds and was composed of 13 percent predators, 22 percent pan fish, and 65 percent weed fish. About 30 percent of all the fish taken were desirable game and pan species more than 0.25 pound each. Although all species are reproducing, the predator ratio and availability of harvestable sizes were low. Depressed growth rates for bluegills, yellow perch, and white perch (unpublished data) indicate further an overcrowded condition for these species.

TABLE 4.--Composition of yield by spot-poisoning of cove sites at various Massachusetts public fishing waters in midsummer, 1951

Species	Ponkapoag Pond[1]			Winneconnet Pond[2]		
	No.	Lbs.	(Percent)	No.	Lbs.	(Percent)
Largemouth black bass	70	17.6	(40.6)	10	0.4	(1.5)
Chain pickerel	30	6.5	(15.0)	4	1.0	(3.6)
Bluegill	213	12.8	(29.6)	78	5.0	(18.2)
Pumpkinseed	17	1.7	(3.9)	8	1.8	(6.5)
Yellow perch	61	3.6	(8.3)	86	7.8	(28.4)
White perch	-	-	-	18	7.4	(26.9)
Black crappie	-	-	-	-	-	-
Brown bullhead	15	1.1	(2.5)	4	.4	(1.5)
Golden shiner	-	-	-	28	3.0	(10.9)
Lake chubsucker	-	-	-	1	.3	(1.1)
Redfin pickerel	-	-	-	2	.1	(.4)
Johnny darter	-	-	-	4		
Bridled shiner	-	-	-	5	.3	(1.1)
Totals	405	43.3	(99.9)	248	27.5	(100.1)

[1] Cove area treated = 1.0 acre.
[2] Cove area treated = 0.5 acre.

TABLE 5.--Composition of overnight gill-net catches at various Massachusetts public waters, summer, 1951

Species	Ponkapoag Pond			Winneconnet Pond		
	No.	Lbs.	(Percent)	No.	Lbs.	(Percent)
Largemouth black bass	4	4.2	(15.0)	1	6.3	(9.4)
Chain pickerel	5	6.6	(23.6)	4	2.5	(3.7)
Bluegill	4	.8	(2.8)	11	3.0	(4.5)
Pumpkinseed	10	2.1	(7.5)	11	1.5	(2.2)
Yellow perch	8	3.3	(11.8)	11	4.0	(6.0)
White perch	-	-	-	-	-	-
Brown bullhead	8	4.2	(15.0)	13	6.0	(8.9)
Golden shiner	27	6.8	(24.3)	109	38.3	(57.2)
Lake chubsucker	-	-	-	5	4.4	(6.6)
White sucker	-	-	-	1	1.0	(1.5)
Totals	66	28.0	(100.0)	166	67.0	(100.0)

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THE DISINFECTION OF EYED TROUT EGGS

Procedures for the disinfection of eyed trout eggs with such materials as merthiolate, sulfo-merthiolate, and acriflavine have been the subject of considerable study at the Fish and Wildlife Service's Leetown (Kearneysville, West Virginia) Station. Dr. S. F. Snieszko of the Microbiological Laboratory at that station has summarized the results of these studies for the benefit of fish-culturists.

Sulfo-merthiolate and merthiolate should be used in a concentration of 1:5,000--the highest effective dilution is 1:7,500--for 10 minutes. As these disinfectants are frequently sold as solutions in water or mixed with talcum powder at a rate of 1:1,000, any order for either material should include the specification, "undiluted substance." Acriflavine should be used in a concentration of 1:2,000 for 25 minutes. These substances are highly toxic to Bacterium salmonicida and other bacteria but, if used properly, are not toxic to the eyed trout eggs.

If one of these disinfectants is used, it should be completely dissolved in pure tap or spring water shortly before the treatments are started. The disinfectant should be prepared in a quantity sufficient for the complete immersion of the eggs and the trays or screens. The eyed eggs should be removed from the packing material, brought gradually to the temperature of the water, rinsed well in clean water, and--after the dead eggs have been removed--should be distributed in the usual manner on the hatching screens or trays. The trays or screens of eggs should then be immersed in the disinfectant, the temperature of which should be as close as possible to the temperature of the water in which the eggs were rinsed and in which they will be hatched. The trays containing the eggs should be immersed in the disinfectant to insure the destruction of the bacteria that might be on any part of the tray. During the treatment these eggs should be agitated with a feather or by means of a gentle shifting of the trays. Eggs being disinfected with sulfo-merthiolate or merthiolate should be agitated every 2 to 3 minutes; if disinfected with acriflavine, eggs should be agitated every 5 minutes. After completion of the treatment the eggs should be rinsed in fresh water or transferred with the trays to a hatchery trough that has a flow of water sufficient for the fast removal of the disinfectant.

Eggs can also be disinfected by placing them in a cheesecloth and immersing them with the cheesecloth in the disinfectant for the required time.

Available information indicates that about 5 grams of each disinfectant should be sufficient to disinfect about 100,000 eggs. The disinfecting solution should be renewed if more eggs are to be treated. It is important that the disinfecting solution be aerated well between each batch of eggs.

The disinfection of the eggs is justified only if other sanitary measures are strictly observed. Therefore, all packing materials must be burned or disinfected with a strong hypochlorite solution. All utensils which were in contact with eggs before disinfection must also be disinfected, and the hands must be washed in a disinfectant (as merthiolate, hypochlorite, or roccal in a concentration of 1:1,000) before touching trays that hold disinfected eggs. All troughs in which disinfected eggs will be hatched should also be disinfected. Water entering the hatching troughs should not be allowed to harbor fish, frogs, or other aquatic animals. Disinfection of the eggs would be quite useless if the disinfected eggs were exposed to recontamination.

COMMERCIAL AND SPORT FISHING

A REITERATION OF POLICY

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THE ARGUMENT WAXES AND WANES and, like many another argument, accomplishes little toward settling a difference of opinion. I do not propose a means for settling the dispute forever; I do think that an armed truce, pending the accumulation of the facts, would go far toward greater amicability between the angler and the commercial fisherman. In the meantime, a close look at both sides might be rewarding:

Says the Sportsman:

When meat fishing is injurious to sport fishing, the commercial interests must give way. A fish which gives an angler a thrill serves a more useful purpose than a fish which finds its way to you via the meat market.

Anglers can't deplete a resource--most fishermen can't even catch fish; they angle for relaxation.

We only want a fair share of the fishing and will be perfectly satisfied if our few favorite marine and fresh-water fishes are reserved. The commercial fishermen can have the rest.

When we see commercial fishermen taking tons of fish from our favorite fishing spots, we resent it, especially when we see illegal sizes dumped to die unused.

If either group must have priority, that group should be the many thousands of sport fishermen who pay far more than the market value of the fish for the privilege of catching them.

Where commercial fishermen are allowed in fresh-water lakes and reservoirs to remove rough fish, they take the game fish, too.

The sport fishery is worth many times the entire commercial fishery and must be preserved, and the commercial fisherman should be brought to understand the importance of preserving this immense asset.

Unfortunately, as in the California mackerel fishery, some commercial fishermen not only destroy their future livelihood by overexploitation, but they destroy our fishing as well. We have plenty of justification for fighting the commercial interests.

A veteran salmon angler on the Columbia says that for years he hasn't caught a salmon which didn't have net marks on it.

Some commercial fishermen even contribute part of their profits to funds used for preventing the passing of regulations which will preserve our fish supply.

We have been forced to organize sportsmen and conservationists in such groups as the Ocean Fish Protective Association, Inc., to combat the overexploitation of important fish species, because of the powerful influence of the commercial fishermen.

In any place where the meat fisherman and the angler vie for the same species, the meat fishing can be expected to reduce the catch of the sport fisherman.

The greatest value of angling is its contribution to health and well-being, which cannot be measured in dollars; but studies of the actual monetary value of recreational fishing demonstrate its great economic importance. One survey report gave average expenditures of more than $9 per fisherman day on an inland reservoir.

Says the Commercial Fisherman:

A lot of sportsmen are as commercial as I am; they sell their fish on the market, competing with me. What's the real difference between us?

Catch statistics are beginning to show what people have been slow to believe without them: in many places sport fishermen take more of a particular species than we do.

In a good many inland lakes and reservoirs we could, if permitted, remove nongame fish

for commercial use to the advantage of the angler because the game fish would have more space and food.

Modern conservation means fullest possible use. Set aside a fish solely for the angler and you risk under-utilization.

We provide high-quality protein food to the American people, many of whom are not sportsmen. Does anyone doubt the need for such food?

We know of many fish hogs who call themselves sportsmen, who load their car trunks with hook-and-line-caught fish; and we know of many instances where such fish have been wasted.

We resent the charge that we "are quite willing to destroy" the supply of salt-water fish, to our "own future disadvantage, as well as to the disadvantage of sport fishermen." We do not believe any one group has a corner on good sense.

We were here first; it is only in very recent years that hordes of anglers have pushed into our fishing grounds.

Even the sportsmen's advocates speak of angling as "big business," and indeed it is. Even the "sportsman" as exemplified and glorified by the party boat and charter-boat operator who takes parties of 2 to 50 people out fishing for commercial species, isn't at all compatible with either the lone sportsman or the fancy angling club.

Big-time commercial fishing in the T.V.A. reservoirs hasn't seemed to make a dent in the sportsmen's catch; and in Iowa, Wisconsin, and Minnesota it has been proved to result in greater angling success.

Sure, we have among us people completely ignorant of conservation, people who flagrantly affront the majority's antipathy to wanton waste and violate conservation laws and regulations; but we have seen long lists of violations--by "sportsmen"--of hunting and fishing laws and regulations designed to prevent waste and perpetuate hunting and fishing. Don't judge us all by the standards of the few.

We really feel strongly about the immoral quality of the efforts expended by groups of anglers to set aside areas, bodies of water, or species of fish for themselves in the interest of "Conservation." The emotional appeal undoubtedly is strong, but in most cases the motive is the interest of special privilege for a special group, often just for a special group of anglers who like to fish in a special way (no worms!).

We don't like to be sneeringly called "meat fishermen" by the anglers. We are 165,000 businessmen, primary producers of food worth $345,000,000 a year to us.

Fish and Wildlife Service Policy

Now, the Fish and Wildlife Service has a policy on this question. In fact, the Service was less than 3 months old when a statement of policy was demanded. The New York State Sportsmen's Council asked for a speaker at a mass meeting, expressing the hope that the person chosen would be sympathetic to the problems of the sport fishermen and not one primarily interested in the commercial fisheries. That was in 1940, just after the union of the Bureau of Fisheries and the Biological Survey. In the years since then, population and fishing pressures, industrialization, needs for more wholesome recreation, and needs for more protein food have, if anything, accentuated the competition between fishing groups.

The Fish and Wildlife Service is, in one way, in a good position in the argument. The Service, you see, has no regulatory jurisdiction over the fisheries of the several States, and only recommends conservation measures to the States for consideration. This distinction between the advisory capacity of the Service and the regulatory power of the States is clear, and the policy is based on this principle.

Former Assistant Director Charles E. Jackson was spokesman for the Service at the mass meeting in New York. The policy which he expressed then not only is applicable today--it needs reiteration for a new generation of anglers, commercial fishermen, and administrators.

The Fish and Wildlife Service will not take sides on the issue and will continue to divorce itself from any division as between the commercial fishermen and the sports fishermen. It is not concerned with social and political issues or in controversies between groups of fishermen. This is not an attempt to avoid responsibility, for the Service is an agency for the conservation of certain living natural resources and is responsible for recommendations to the States based upon research results. The Service is <u>against</u> waste, against overfishing, and against depletion; but it does not proceed or recommend on the basis of suspicions of waste, overfishing, or depletion or irresponsible charges of these crimes against conservation. The Service is <u>for</u> research to build up a fund of information usable for conservation purposes.

A corollary policy worth mentioning again is that where a fish resource is not sufficiently large to permit both commercial and recreational fishing, the resource should be used in such a manner that the greatest

number of citizens will benefit. The well-known Federal and State laws prohibiting the taking, transportation, sale, and possession of black bass for commercial purposes were based on this related policy. In the case of many other species, the benefit accrues to the recreational fishermen.

The facts do not justify exclusion of one kind of fishing for the benefit of another kind for most marine fishes. Of course, either side may advocate exclusion, but the Service will not support one side against another. The fishery resources of the United States do not belong to the commercial fishermen and they are not the property of the recreational fishermen. They belong to all the people.

The protection needed by both sides in the controversy is provided through adequate technical information, coordinated jurisdiction over migratory fishes, and a rational management policy. In the years since Mr. Jackson spoke in New York, more knowledge about fishes has been accumulated, inter-State compacts on the three coasts have provided the means for coordination, and at least some progress has been made toward more rational management. Still, fishery conservation is in its infancy. The best way to adjudicate the argument between sport and commercial fishermen is to support ardently the three means of protection of the resource, which I have listed. Active, constructive support of sportsmen's or commercial fishermen's associations, cooperation with Federal and State fact-finders who are trying to acquire the information necessary to a rational conservation program, individually expressed interest in good conservation legislation, and acceptance of a more equitable distribution of conservation costs between the fresh-water and salt-water anglers and between anglers and commercial fishermen: these are some of the ways in which a reasonable compromise between groups may be reached more quickly than through a running fire of criticism.

BROWN AND RAINBOW TROUT SURVIVAL STUDY ON CONVICT CREEK IN CALIFORNIA

A study of survival of brown and rainbow trout has been part of the work undertaken by the U. S. Fish and Wildlife Service at the Convict Creek Experimental Station in California.

To determine the causes underlying enormous overwinter losses of trout, research workers set aside four stream sections of Convict Creek for observation of the effects of various weather conditions upon the fish. Within these sections, the length of which totaled a mile, the water flow and the movements of the fish could be controlled. The study program for these sections included the recording of stream flow, air temperatures, water temperatures, velocity, snowfall, and ice formation.

During the last 2 years, one of these sections has been stocked in April with stream-resident brown trout, two sections have been stocked with hatchery-reared rainbow trout, and the fourth section has been stocked with equal numbers of the two species. The check made on these sections early in November 1951 revealed the presence of 37 percent of the rainbow trout and 39 percent of the brown trout. These survivors had made good growth and were in excellent condition. About the middle of November, however, a series of almost weekly snowfalls and windstorms began. In consequence, Convict Creek had a cover of 1 to 12 feet of snow and ice for the next 5 months. In April 1952, when less severe weather made it possible to resume observations, a check of the populations in the four stream sections revealed that the gross winter survival of the brown trout was 16 percent greater than that of the rainbow trout. The brown trout had made little growth during the winter, and their condition had declined noticeably. The remnants of the rainbow trout populations were small, and there were no particular indications of growth or change in condition.

The bottom samples that were taken on these sections in the spring of 1952 indicated an extreme paucity of food. Additional factors that contributed to the heavy winter losses recorded for these sections included the prolonged low water temperatures, absence of light, collapse of snow and ice with resulting back-up of water, insecure shelter, and partial or complete drying-and-freezing of stream bottom areas.

A SIMPLIFIED TECHNIQUE FOR CLASSIFING STREAMS USEFUL IN FISHERY AND RELATED RESOURCE MANAGEMENT

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DURING THE PAST FOUR YEARS an inventory of the State's natural resources--forests, water, fish, and game--has been in progress. In order to categorize properly the various stream conditions, from the mountains to the oceanside, a State-wide classification was proposed. Since the information was to be incorporated into watershed reports and action programs, it was felt that the classes of streams should be presented in realistic and simplified form. Therefore, the 11 basic classes were set up and each was given the name of the fish that one would expect to find under the existing conditions. Critical period observations were also made during the periods of high temperature and low water so as to determine extremes of environmental conditions. Figure 1 presents the classification

MARYLAND STREAM CLASSIFICATION

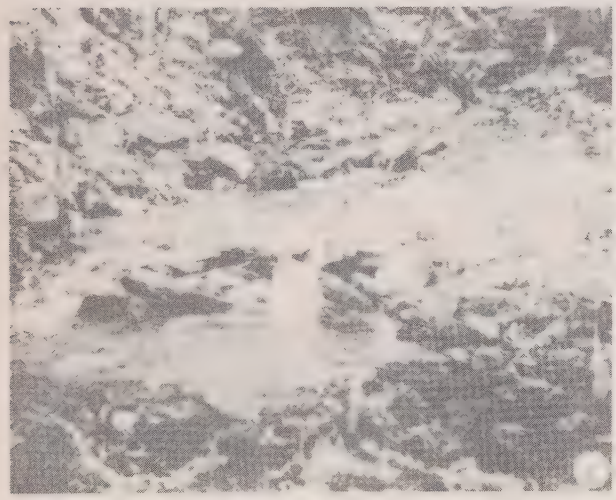
NATURAL RESOURCES INVENTORY
DEPARTMENT OF RESEARCH & EDUCATION; SOLOMONS, MARYLAND

CODE NO.	STREAM CLASS	WIDTH (FEET)	DEPTH	TEMP.	WATER QUALITY	BOTTOM	FLOW	VOLUME	CHARACTERISTIC FORMS	SHADE AND COVER	MISCELLANEOUS CHARACTERS
1	DACE TRICKLE	0 TO 3	VERY SHALLOW	COOL	USUALLY CLEAR CLEAN WATER EXCEPT IN SPRING	BOULDERS GRAVEL SAND	LITTLE	LITTLE	BLACKNOSE DACE	USUALLY HAS SOME FOREST COVER, BUT MAY HAVE NONE	EXTREME UPPER REACHES OF MOST STREAMS
2	TROUT FEEDER	0 TO 7	SHALLOW	COLD	CLEAR, CLEAN WATER.	RUBBLE TO GRAVEL	LITTLE TO MEDIUM	LITTLE TO MEDIUM	TROUT, MUDDLERS & CREEK CHUBS	MODERATE SHADE INSUFFICIENT STREAM COVER FOR THE LARGE FISH	WATER VOLUME NOT ENOUGH TO SUPPORT LEGAL-SIZED TROUT POPULATION
3	TROUT STREAM	5 AND OVER	SHALLOW WITH POOLS	COLD	CLEAR, CLEAN WATER.	RUBBLE TO GRAVEL	MEDIUM TO MODERATE	MEDIUM TO MODERATE	TROUT, MUDDLERS RIVER & CREEK CHUBS	MODERATE AMOUNT OF SHADE AND COVER FOR FISH	WITH TROUT FEEDER STREAMS FLOWING INTO MAIN AXIS
4	SUCKER STREAM	3 TO 20	MEDIUM	COOL	INTERMEDIATE; MAY CARRY SILT AT TIMES.	SAND AND GRAVEL	MEDIUM	MEDIUM	COMMON SUCKER AND COMMON SHINER	LACKS SHADE & COVER	HAS CHARACTERISTICS OF A TROUT STREAM AND MAY FALL BELOW
5	BASS FEEDER	10 AND OVER	SHALLOW WITH POOLS	COOL	CLEAR TO SLIGHTLY TURBID WATER	SAND AND GRAVEL	MEDIUM	MEDIUM	SMALLMOUTH BASS CRAYFISH AND MUSSELS	MEDIUM AMOUNT OF COVER AND SHADE	INSUFFICIENT VOLUME OF WATER TO SUPPORT LEGAL POPULATION OF BASS
6	BASS STREAM	20 AND OVER	MEDIUM WITH POOLS	COOL	CLEAR TO SLIGHTLY TURBID WATER	SAND AND GRAVEL	MODERATE	MODERATE	SMALLMOUTH BASS CHUBS AND CRAYFISH	MEDIUM AMOUNT OF SHADE & MODERATE AMOUNT OF COVER	SUFFICIENT VOLUME AND DEEP POOLS
7	PICKEREL STREAM	20 AND OVER	MODERATE WITH POOLS	COOL TO WARM	DARK, TURBID WATERS	MUCK & SAND	MEDIUM TO SLOW	MEDIUM	CHAIN PICKEREL, SUNFISH & CRAPPIE & GOLDEN SHINER	MODERATE SHADE AND COVER	AQUATIC VEGETATION SERVES AS STREAM COVER
8	BULLHEAD STREAM	20-50	MEDIUM	WARM TO COOL	TURBID WATER	MUD & MUCK	LITTLE TO MEDIUM	MEDIUM TO LITTLE	BULLHEADS & VARIETY OF SUNFISHES	MEDIUM SHADE & COVER	ONLY OCCASIONAL POOLS
9	CATFISH STREAM	70 AND OVER	MODERATE	COOL TO WARM	TURBID WATER	MUD SAND GRAVEL	MEDIUM	MEDIUM AND MODERATE	CATFISH, BULLHEADS AND VARIETY OF PANFISHES	MEDIUM SHADE & COVER	FREQUENT DEEP POOLS
10	CARP STREAM	70 AND OVER	MEDIUM-MODERATE	WARM	MUDDY, SOMETIMES HIGHLY TURBID WATER	MUD & MUCK	MEDIUM	LITTLE TO MEDIUM	CARP, SUNFISHES & CATFISH IN MARGINAL AREAS	LITTLE SHADE & COVER	CHARACTERIZED BY ONLY A FEW SPECIES OF FISH PRESENT
11	TIDAL STREAM	5 AND OVER	MEDIUM	WARM	SEASONALLY CLEAR & MUDDY MORE OR LESS BRACKISH	SAND MUCK PEAT	SLOW TO MEDIUM	MEDIUM	VARIETY OF FRESH AND BRACKISH WATER FORMS	SHADE SPARSE & LITTLE STREAM COVER	SHALLOW TO DEEP CHANNELS WITH BARS

FIGURE 1.--Maryland stream classification.

and indicates how the stream classes vary with regard to width, depth, temperature, water quality, type of bottom, flow, volume, forms present, amount of shade and cover, and miscellaneous characteristics.

Conducting a basic stream inventory can be accomplished in a shorter length of time

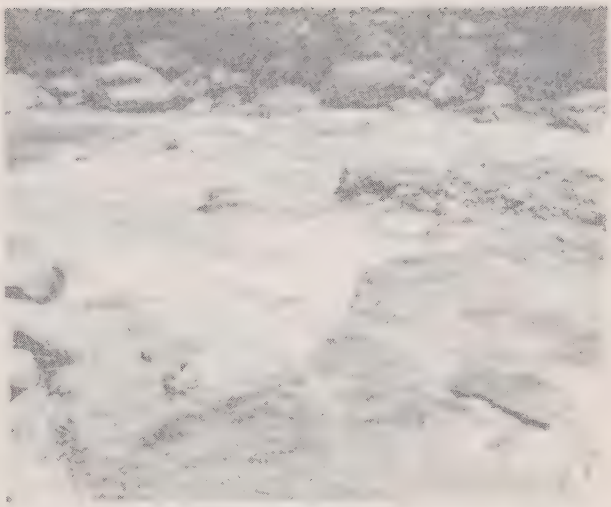


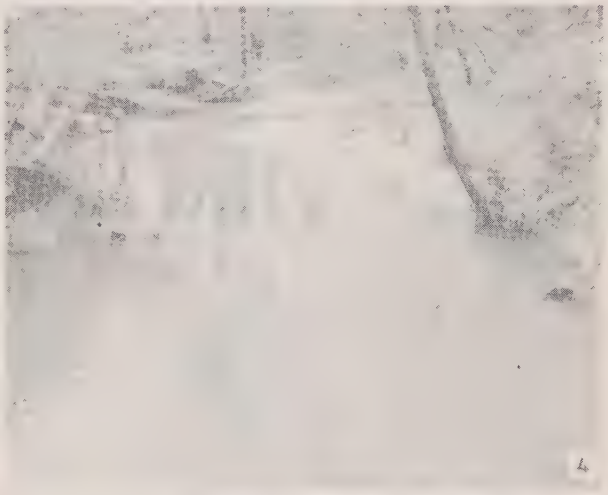
(1) DACE TRICKLE: Tiny tributary streams, cool shallow water, with little flow, minimum shade and cover.

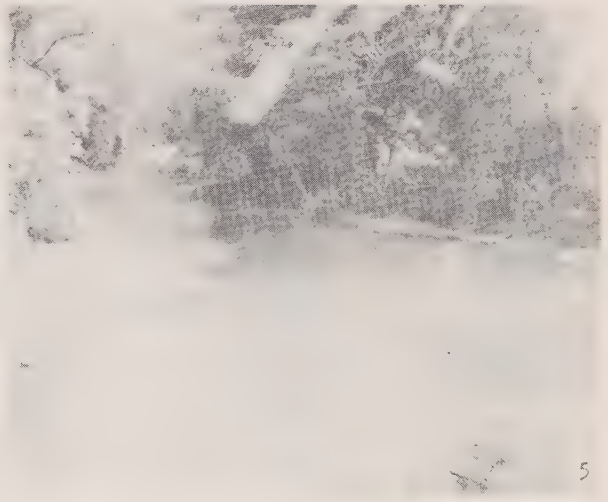
(2) TROUT FEEDER: Small headwater streams, shallow, with few pools, clear cold water, gravel bottom, moderate shade and cover.

(3) TROUT STREAM: Medium to large cold-water streams, shallow, with frequent pools, gravel and rubble bottom, moderate shade and cover.

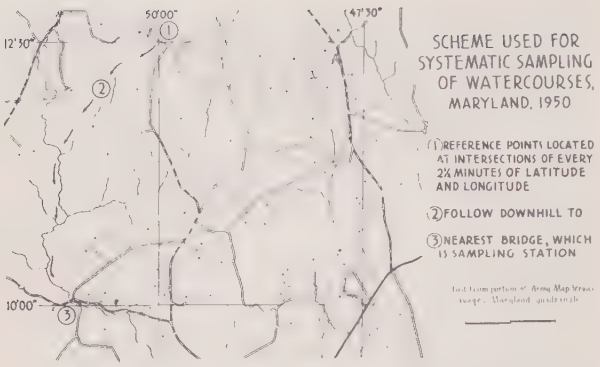
(4) SUCKER STREAM: Small to medium-sized, cool-water streams, shallow, with shifting sand gravel bottom, little shade and cover.







(5) BASS FEEDER: Medium-sized cool-water streams, rather shallow, with few pools, with insufficient water volume to support population of legal-sized bass.


50'00"
47'30"
12'30"
10'00"
SCHEME USED FOR SYSTEMATIC SAMPLING OF WATERCOURSES, MARYLAND, 1950
(1) REFERENCE POINTS LOCATED AT INTERSECTIONS OF EVERY 2½ MINUTES OF LATITUDE AND LONGITUDE
(2) FOLLOW DOWNHILL TO
(3) NEAREST BRIDGE, WHICH IS SAMPLING STATION

(Above) FIGURE 2.--Examination points.

if a systematic sampling scheme is devised. A method of selecting reference points located at the intersection of every 2½ minutes of latitude and longitude on 1:25,000-scale quadrangle maps was used in the Maryland survey. To find the actual examination points, one finds the stream nearest the reference point and thence downstream to the nearest bridge or ford. (See figure 2.) Sampling stations so chosen were then appraised of their description--physical, chemical, biological, and economic qualities. (See figure 3.)

FIGURE 3.--Code sheet (below) and field data sheet (righthand page).

GENERAL

COUNTIES
1. Allegany
2. Anne Arundel
3. Baltimore
4. Baltimore City
5. Calvert
6. Caroline
7. Carroll
8. Cecil
9. Charles
10. Dorchester
11. Frederick
12. Garrett
13. Harford
14. Howard
15. Kent
16. Montgomery
17. Prince George's
18. Queen Anne's
19. St. Mary's
20. Somerset
21. Talbot
22. Washington
23. Wicomico
24. Worcester

MANAGEMENT REGION
1. Western
2. Piedmont
3. Southern
4. N. Central
5. Upper Shore
6. Lower Shore

PRIMARY DRAINAGE
1. Atlantic
2. Delaware
3. E. Chesapeake
4. Susquehanna
5. W. Chesapeake
6. Potomac
7. Ohio

WATERSHED
1. Pocomoke
2. Choptank
3. Chester
4. Gunpowder
5. Patapsco
6. Patuxent
7. Severn
11. Savage
12. Town Hill
13. Tonoloway
14. Conococheague
15. Antietam
16. Lower Monocacy
17. Upper Monocacy
18. Seneca
19. Anacostia
20. Northeast
21. Susquehanna
22.
23.
33.

ECONOMIC

EROSION
1. Present
2. Absent

TYPE
1. Sheet
2. Gully
3. Cattle
4. Road Cut
5. Stream Bnk.

DEGREE
1. Slight
2. Medium
3. Severe

PASTURING
1. Present
2. Absent

KIND
1. Horses
2. Cattle
3. Sheep

DEGREE
1. Slight
2. Medium
3. Severe

POLLUTION
1. Present
2. Absent

TYPE
1. Chemical
2. Silt
3. Junk & Refuse
4. Sewage
5. Sawmill
6. Canneries

DEGREE
1. Slight
2. Medium
3. Severe

FLOODING
1. Present
2. Absent

DEGREE
1. 0-2 feet
2. 3-6 feet
3. 7-10 feet
4. Over 10 feet

DESCRIPTION

AVERAGE WIDTH
1. 0 - 5'
2. 6 - 10'
3. 11 - 20'
4. 21 - 30'
5. 31 - 40'
6. 41 - 50'
7. 51 - 100'
8. 100 - over

AVERAGE DEPTH
1. 0 - 6"
2. 7"- 2'
3. 2'- 5'
4. 6'- 15'
5. 16'- over

RATE OF FLOW
1. Slow (2 MPH-less)
2. Medium (2-5 MPH)
3. Fast (over 5 MPH)

POOL SIZE
1. Aver. Wid. & Long.
2. As Wide or as Long
3. Aver. Narrower & Shorter

POOL TYPE
1. Deep-2 ft. with shel. & plants
2. " " " no " "
3. Intermediate
4. Shallow exp. pools, with shel. & plants.
5. " " " without "

POOL FREQUENCY
1. More or less cont. 75% pools & 25% riff.
2. Close succession 50% pools & 50% riff.
3. Shallow pools 25% or less

BOTTOM TYPES
1. Organic
2. Inorganic

ORGANIC
1. Detritus
2. Peat
3. Muck

INORGANIC
1. Bed Rock
2. Boulders
3. Coarse Rubble 7-12"
4. Fine Rubble 3-6"
5. Coarse Gravel 1-3"
6. Fine Gravel 1/8-1"
7. Sand
8. Silt
9. Clay
10. Marl

PHYSICAL

COLOR
1. Less than 5 ppm.
2. 5 to 10 ppm.
3. More than 10 ppm.

SECCHI DISC
1. Clear 10' over
2. Sl. Tur. 5-10'
3. Tur. 2-5'
4. Den. Tur. 10"-2'
5. Soup less 10"

TEMPERATURE LAG
1. 16° over
2. 9-15°
3. 4-8°
4. 0-3°

TIDE
1. High
2. Low
3. None

BIOLOGICAL

SHADE
1. 75% to 100%
2. 50% to 75%
3. 25% to 50%
4. 5% to 25%
5. 0% to 5%

COVER
1. Abundant
2. Medium
3. Sparse

AQUATIC PLANTS
1. Present
2. Absent

Abundance
1. Abundant
2. Medium
3. Sparse

FISH FOODS
1. Present
2. Absent

Abundance
1. Abundant
2. Medium
3. Sparse

PREDATORS
1. Present
2. Absent

Abundance
1. Abundant
2. Medium
3. Sparse

CLASSIFICATION

STREAM CLASSIFICATION
1. Dace Trickle
2. Trout Feeder
3. Trout Stream
4. Sucker Stream
5. Bass Feeder
6. Bass Stream
7. Pickerel Stream
8. Bullhead Stream
9. Catfish Stream
10. Carp Stream
11. Tidal Stream

After the sampling is completed at the randomly chosen stations, the balance of the unsurveyed areas are viewed from the remaining bridges and access points. The class numerals are placed on the map along the stream axis where there is a change in stream class. One further aid in streamlining the data-taking was to code the various information into a list of stream survey keys. Thereby all columns except the chemical data could be transferred directly by means of code numerals instead of laborious and repetitious writing in longhand.

Stream classification maps to the scale of 1:62,500 have been completed for the entire State. Each map contains the appropriate skeleton stream system as shown, for example, in figure 4. Circles are placed along the stream course where one stream class grades into another. A code number is placed in each

(6) BASS STREAM: Large cool-water streams, medium depth, with large pools, gravel and rocky bottom, with moderate shade and cover.

STREAM SURVEY
NATURAL RESOURCES INVENTORY, DEPARTMENT OF RESEARCH AND EDUCATION
SOLOMONS, MARYLAND

QUADRANGLE _____ R.P. _____

PRIMARY DRAINAGE _____ WATERSHED _____ NAME of STREAM _____ COUNTY _____

LOCATION _____ GRID _____

DATE _____ TIME _____ A.M., P.M. COLLECTION NO. _____ MANAGEMENT REGION _____

DESCRIPTION

Ave. Width _____
Ave. Depth _____
Flow Rate _____
Volume _____
Pool Size _____
Pool Type _____
Pool Freq. _____
Bottom Type _____
Inorganic _____
Organic _____

PHYSICAL

Weather _____
_____
Sky _____
Air Temp. _____
Max. _____
Min. _____
H_2O Temp. _____
Max. _____
Min. _____
Temp. Lag _____
Tide _____

CHEMICAL

pH _____
O_2 _____
CO_2 _____
PHTH _____
M.P. _____
Odor _____
Color _____
Secchi Disc _____
Turbidity _____

BIOLOGICAL

Shade _____
Cover _____
Aquatic Veg. _____

Kind	Abu.
1.	
2.	
3.	

Fish Foods _____

Kind	Abu.
1.	
2.	
3.	

Predators _____
Abundance _____

ECONOMIC

Erosion _____

Type	Degree
1. Sheet	
2. Gully	
3. Cattle	
4. Road Cut	
5. Stm. Bk.	
6.	

Pasturing _____

Type	Degree
1. Horses	
2. Cattle	
3. Sheep	
4. Others	
5.	

Pollution _____

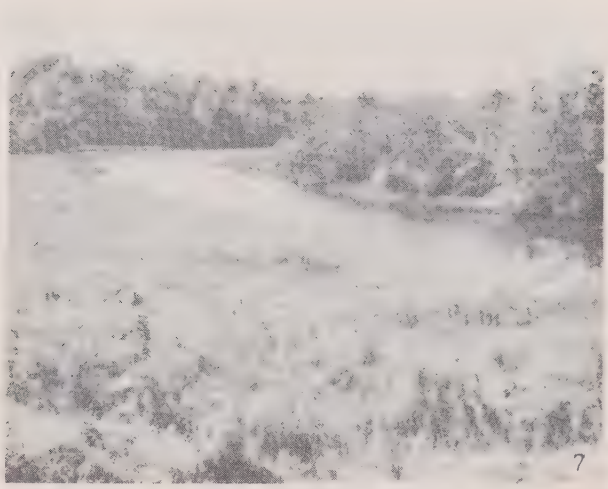
Type	Degree
1. Chemical	
2. Silt	
3. Junk	
4. Sewage	
5. Sawmill	
6. Cannery	
7.	

Flooding _____
Degree _____

STREAM CLASSIFICATION _____ Notes _____

Management Suggestions _____

Analyzer _____



(7) PICKEREL STREAM: Medium-sized, cool to warm-water streams, moderate depth, slow-moving, usually with submerged aquatics; water dark colored and inhabited by chain pickerel and largemouth black bass.

(8) BULLHEAD and CATFISH STREAM: Large, deep, slow-moving streams, long pools, cool to warm water, usually turbid throughout most of the season.

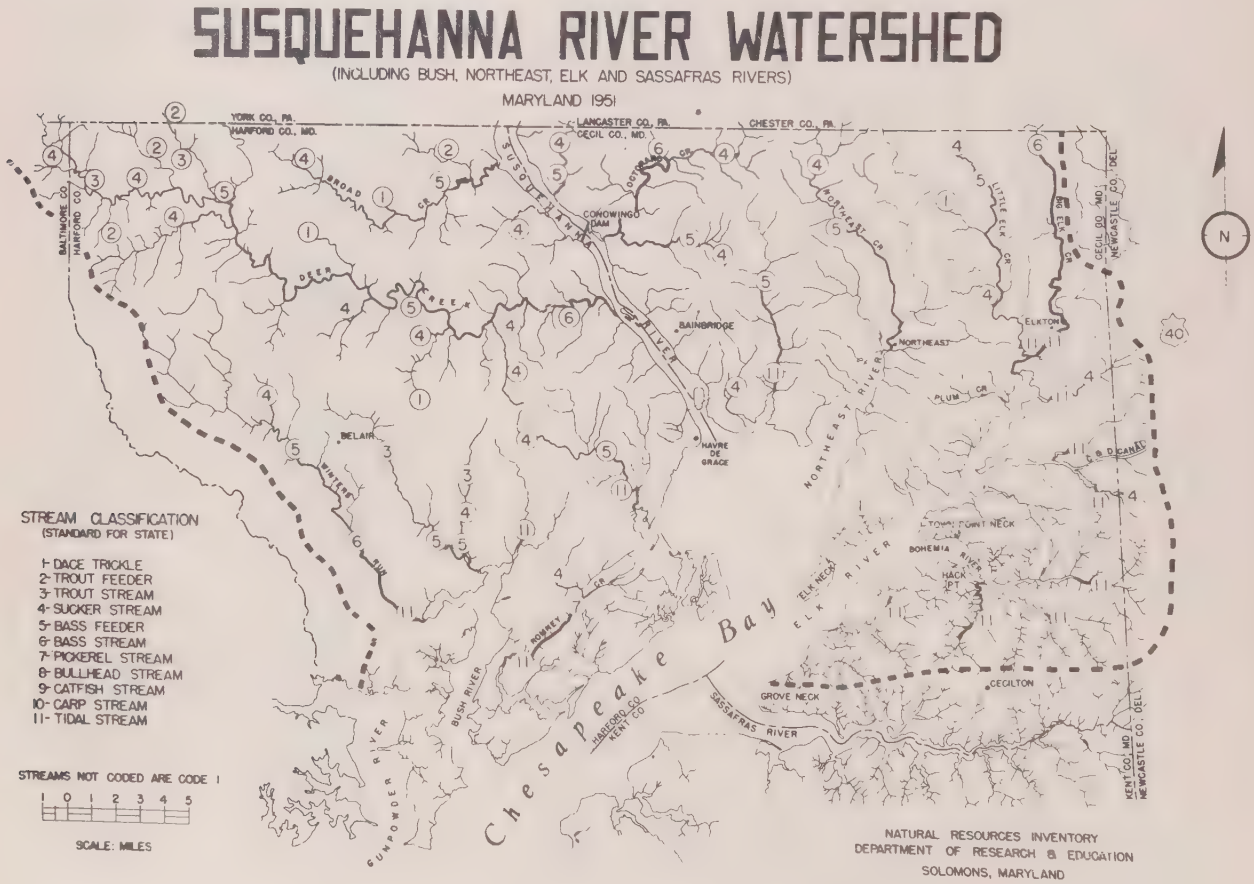
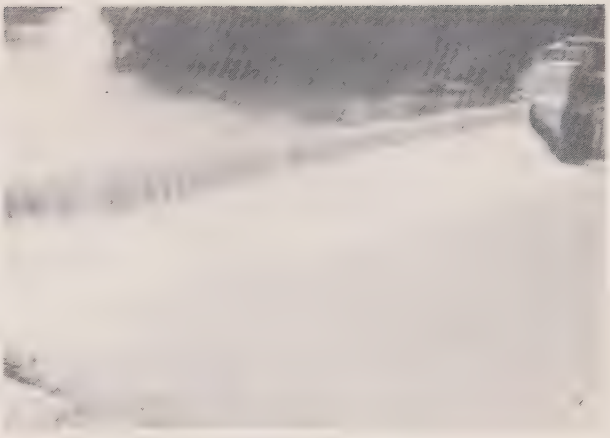


FIGURE 4.--Stream classification.

circle to designate the stream class in that section downstream to the next circle. Where there is a sufficient amount of pollution present to become detrimental to fish life, a small letter (p) accompanies the code number.

The completed watershed maps are useful in many ways. They present a graphic and basic inventory of the kinds of streams within a river system. The maps serve the fish manager with a base for obtaining a linear measure of the various classes of streams, and a base for management or law enforcement use. Ozalid prints of map tracings can be obtained for a few cents each, and photographic prints can also be made to fit into the brief-case. Probably of most importance, they represent a tool in fishery management around which plans can be laid for the future improvement of marginal-classed areas.



(9) CARP and TIDAL STREAM: Carp stream meets tidal water; warm polluted stream supports mainly carp and sunfish.

DEFLECTORS USED IN STREAM-IMPROVEMENT PROGRAMS

Stream-improvement programs frequently include the installation of some type of deflector. When properly installed, deflectors are less subject to destruction than dams and less disturbing to the stream bottom.

A primary purpose in the use of deflectors is the creation of pools. A deflector constructed to form a pool constricts the channel and thus increases the cutting power of the stream flow. The material scoured from the bottom is deposited on one side of the stream and is usually exposed during periods of normal flow. It is possible then to establish vegetation upon this deposit and eventually to maintain a permanent condition there even if the deflector is removed.

The necessity to protect eroding banks may involve the use of deflectors. Placed so that they will not cause further erosion of the stream banks, the deflectors are usually installed in pairs: use of single deflectors should be restricted to positions opposite a bank of solid rock or other non-erodible material. Ordinarily a single long deflector may be less effective than a series of short deflectors, and an extremely long area of erosion--especially an area of unstable, sandy banks--may require a continuous wall. Wire-crib deflectors have been satisfactory in hard-bottomed streams with large flows; deflectors made of sheet-piling have been most satisfactory in soft- or sandy-bottomed streams. It should be noted, however, that in most instances where deflectors have been used to halt erosion, lasting results have been obtained only by the establishment of protective vegetation. Here the real purpose in using deflectors has been to stop the erosion long enough to permit the vegetation to become permanent.

A third major use of deflectors in stream-improvement programs is to concentrate the stream flow in a particular channel or divert the flow from undesirable side channels. Such action, aside from increasing small flows, may have the effect of reducing water temperature.

Thirty-four trout redds on Arnica Creek, Yellowstone National Park, were studied by research workers of the Fish and Wildlife Service in the summer of 1952 to determine the survival of eggs. The average number of eggs deposited in single nests was close to 450; the remainder of the approximately 1,000 eggs per female was deposited in other nests. The mortality, measured by counting individual eggs, amounted to 22.1 percent after 4 days in the redd and to 33.8 percent after 24 days in the redd.

THE STATUS OF COMMERCIAL AND SPORT FISHING ON REELFOOT LAKE

Eugene S. Cobb
Tennessee Game and Fish Commission
Jackson, Tennessee

REELFOOT LAKE, located in the northwest corner of Tennessee, was created by a sinking of the earth surface during the New Madrid Earthquake of 1811.

Originally the lake embraced an area exceeding 30,000 acres. Owing to vast areas of shallow water, however, aquatic plants and erosion from the surrounding watershed have filled the lake at a rapid rate. At the present time, the area of the lake is approximately 11,800 acres (Eyles 1942).

Reelfoot Lake has long been known as a "fisherman's paradise." Recorded data on productivity for the past years, however, are limited. When the lake was first acquired by the State many years ago, a royalty of about 4¢ per pound was paid to the Game and Fish Commission by the commercial fishermen for fish taken in Reelfoot Lake. Unfortunately, these records were destroyed before creel census studies were considered important. In 1937, the Reelfoot Biological Station of the Tennessee Academy of Science conducted a creel census on the lake (Kuhne 1939a). The average catch for sport fishermen was found to be eight fish weighing 5 pounds; however, the author reported that the cooperation by the boat docks was not too good. Prior to and including this period, game species of all types were taken commercially. The total yield removed by commercial and sport fishermen in 1937 was estimated by Kuhne (1939b) to be 38 pounds per acre. No recorded data are available for the productivity of the lake from the time of this study until 1951. It is to be noted, however, that during this period the sale of black bass was prohibited, although the sale of other sunfish, yellow bass, and crappie was continued, and legal catch limits were applied to all game fish in Reelfoot Lake. In September 1951 the limits on yellow bass, crappie, and sunfish (with the exception of largemouth bass) were removed for commercial fishermen; and in April 1952 these limits were also removed for the sport fishermen.

For several years prior to 1951, the commercial fishermen were not allowed (by law) to catch more than 60 each per day of yellow bass, sunfish (except largemouth bass), and crappie.

The need for a study to determine the status of fishing conditions at Reelfoot Lake has long been recognized. However, with the enactment of liberalized restrictions governing management during the past 2 years, the need has become more apparent. It was with these thoughts in mind that the present study was undertaken.

METHODS

The creel census on Reelfoot Lake began March 1, 1952, and is still in progress. The material for this report, however, includes only data obtained through September 30, 1952.

Three men are employed by the Tennessee Game and Fish Commission to record the data from fishermen and are rotated among the larger boat docks which are in operation on the lake at the present time. When sport fishing is heavier in certain areas, rotation is abandoned and the census takers are assigned to certain docks for indefinite periods. In an attempt to check as many fishermen as possible, the census takers report for work at 10:00 a.m. and remain until dark.

The principal data recorded during the census were the numbers and weights of the various species, the catch per person, name of the boat dock, the resident State of the fishermen, and the date. A copy of the form used is reproduced here.

Presented at the Sixth Annual Conference of the Southeastern Association of Game and Fish Commissioners in Savannah, Georgia, October 19-22, 1952.

The annual catch of game species by commercial fishermen was obtained from the Law Enforcement Branch of the Tennessee Game and Fish Commission, which issues bills of lading which must accompany all commercial catches of game fish taken from Reelfoot Lake. The estimated annual take of commercial species is based on the weights of fish handled by the three fish markets located on the lake during the year of 1951.

RESULTS

For the period involved (March 1, 1952, through September 30, 1952), 11,374 sport fishermen were checked in connection with the creel census on Reelfoot Lake. Thirty-five percent of these persons were nonresidents of Tennessee. Of the total number checked, 8,784 (or 77 percent) caught one or more fish, and 2,590 (or 23 percent) were unsuccessful, catching no fish at all. The average creel contained 7.8 fish and weighed 4.3 pounds, with the average fish caught during the period weighing 0.55 pound; and 97 percent of the total number of fish caught by these fishermen were game species. The total monthly weights and average weights of the principal species taken are given in table 1.

With the exception of a limit of 10 on largemouth bass, no creel limits are in effect on Reelfoot Lake. It is of particular interest to note that of 11,374 fishermen checked, only 106 exceeded the State-wide limit of 20 crappie per day, and only 611 exceeded the State-Wide limit of 25 bream (all species of sunfish). This represents a total of only 6 percent "over limit" fishermen. The largest "over limit" creels checked were 50 crappie and 120 bream; however, the average "over limit" catch was only 28 crappie and 39 bream.

FISHING REPORT
TENNESSEE STATE GAME AND FISH COMMISSION
REELFOOT LAKE

Catch per person: 1._____ 4._____
2._____ 5._____
3._____ 6._____

Species	Number	Weight
Crappie, White		
Crappie, Black		
Bluegill		
Yellow Bass (Striped Jack)		
Largemouth Bass		
Warmouth (Goggle-eye)		
Shellcracker (Red-ear bream)		
Bream, Misc.		
Channel Catfish		
Blue Catfish		
Bullheads		
Yellow Catfish		
TOTALS		

Dock or Location of Report: _____

Residents, State of: _____

Observer: _____

Date: _____

For a 12-month period ending September 30, 1952, the commercial catch of sport species consisted of approximately 178,523 pounds of crappie, 71,987 pounds of bream, and 36,956

TABLE 1.--Total monthly weights and average weights in pounds of fish by species, caught by 8,784 sports fishermen from March 1, 1952, through September 30, 1952

Species	March	April	May	June	July	August	September	Total weight	Average weight
Largemouth bass	253.9	1,340.7	948.7	803.3	731.7	1,182.5	825.9	6,086.7	1.93
Yellow bass	5.3	56.4	16.3	13.2	22.3	18.1	84.7	216.3	.48
Bluegill	-	57.6	4,662.5	3,702.1	1,455.0	734.5	100.2	10,711.9	.37
Misc. bream[1/]	.5	125.0	2,879.3	2,712.3	1,441.8	692.3	59.6	7,910.8	.29
White crappie	2,005.8	10,536.0	3,336.2	226.3	799.0	547.4	2,631.9	20,082.6	.88
Black crappie	32.3	383.0	4.2	20.2	31.5	5.1	-	476.3	1.00
Warmouth	2.5	136.8	235.9	69.8	287.8	214.9	58.5	1,006.2	.29
Shellcracker	-	2.2	140.7	45.3	12.2	9.6	3.6	213.6	.37
Drum	-	15.9	28.1	41.5	30.9	24.5	15.0	155.9	1.55
Channel catfish	-	39.2	149.0	110.8	189.6	285.7	429.4	1,203.7	1.83
Other catfish	-	42.3	83.6	215.0	489.0	167.9	34.9	1,032.7	.58
Carp	-	-	-	-	50.9	-	-	50.9	2.12
Others[2/]	1.4	1.0	3.5	-	2.1	-	-	8.0	1.60

[1/] Lepomis megalotis, L. cyanellus, L. punctatus.

[2/] Eel, buffalo, grinnel.

pounds of yellow bass. The monthly catch by species is given in table 2.

During the year of 1951, a total weight of 353,714 pounds of nongame fish were handled by the three fish markets located on Reelfoot Lake. The catch consisted chiefly of catfish and buffalofish, with smaller weights of carp, drum, and other rough fish. It is understood that these figures represent only a broad estimate of the annual take of commercial fish on Reelfoot Lake, for there is no way to determine the weights of fish marketed through these fish docks from surrounding waters other than Reelfoot, nor is there reason to believe that all the commercial fish taken in Reelfoot Lake find their way to market through these three channels. It is of interest to note, however, that the three markets handled decidedly more fish during the late fall, winter, and early spring than during the sport fishing season, which usually begins in late spring and continues into early fall.

DISCUSSION

The status of sport fishing on Reelfoot Lake at the present time, as revealed by the creel census, may definitely be regarded as favorable. Assuming that the census takers checked approximately one-fifth of the sport fishermen during the period involved, the yield for sport fishermen was in excess of 21 pounds per acre for the lake. This yield is highly favorable when compared to the yield of only 1.53 pounds obtained by sport fishermen in the census taken by Kuhne in 1937.

TABLE 2.--Summary of game fish taken by commercial fishermen in Reelfoot Lake from October 1, 1951, to September 30, 1952

Month	Crappie (pounds)	Bream (pounds)	Yellow bass (pounds)
1951			
October	19,273	5,166	3,841
November	49,255	30,940	8,878
December	27,564	6,767	6,220
1952			
January	27,926	3,646	7,386
February	16,663	784	3,563
March	11,452	1,764	6,924
April[1/]	-	-	-
May[1/]	-	-	-
June	81	781	84
July	2,609	6,374	60
August	9,632	9,072	-
September	14,068	6,693	-
Total	178,523	71,987	36,956

[1/] Closed season for commercial fishing of sports species.

It is enlightening indeed to find that while the numbers of fishermen have increased almost one hundredfold since 1937, the average catch per fisherman remains almost identical.

The fact that 6 percent of the fishermen were able to catch more than the State-wide limits, lends strong evidence to the belief that Reelfoot Lake is well populated with fish and far from being "fished out."

The commercial catch of crappie, bream, and yellow bass is approximately 25 pounds per acre and, although exceeding the total catch by sport fishermen, it is not thought to be large enough to cause undue alarm. It is generally agreed among most fishery workers that in order to prevent overcrowding and to maintain rapid growth rates, heavy cropping of these species is mandatory (Dequine 1952, Schoffman 1950, Swingle 1950, Miller and Bryan 1947, and others).

The yield of commercial species during 1951 is lower than the commercial catch reported in 1937; however, the approximate yield of 21 pounds per acre in 1951 is believed to be higher than for most large bodies of water in the Southeast.

The total weight of fish harvested annually by fishermen from Reelfoot Lake, according to the above estimates, is approximately 67 pounds. Kuhne, in 1937, reported a record total yield of 38 pounds per acre by both commercial and sport fishermen. It may, therefore, be assumed that at the present time Reelfoot Lake is producing almost twice as many pounds of fish per acre as were produced in 1937 and higher yields of fish than have previously been recorded for this body of water.

SUMMARY

1. A total of 11,374 creels were recorded in the Reelfoot Lake creel census between March 1, 1952, and September 30, 1952. Of the total, 77 percent caught one or more fish and 23 percent were unsuccessful. The average creel contained 7.8 fish and weighed 4.3 pounds. The average weight per fish was 0.55 pound. Six percent of the fishermen recorded exceeded the State-wide creel limits on crappie or bream. The average creels for "over limit" fishermen were 28 crappie and 39 bream.

2. The commercial catch of sport species for a 12-month period was 178,523 pounds of crappie, 71,987 pounds of bream, and 36,956 pounds of yellow bass, or an average of 25 pounds per acre annually.

3. The total estimated weight of commercial fish for the year of 1951 was 353,714,

or 21 pounds per acre annually. Catfish and buffalofish dominated the catch.

4. The annual estimated production of all fish taken by both commercial and sport fishermen in Reelfoot Lake is in excess of 67 pounds per acre.

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TITLES AND TOPICS OF INTEREST TO FISHERY WORKERS

The Southeastern Association of Game and Fish Commissioners held its sixth annual conference at Savannah, Georgia, October 19-22, 1952. Fishery workers in attendance held the first meeting of the Southern Division of the American Fisheries Society and elected officers for the coming year.

The following list of titles and discussion topics has been compiled from the program. Anyone desiring to obtain a copy of a particular paper or information regarding a discussion should write to the author or chairman concerned.

Methods of collecting and uses of creel census data in the Southeast. Round table discussion.
Chairman: Larry Miller, Tennessee Valley Authority.

Growth studies and notes on the redeyed bass, Micropterus coosae, Hubbs and Bailey.
John Parsons, Tennessee Game and Fish Commission.

Age and growth studies in Florida.
Melvin Huish, Florida Game and Fresh Water Fish Commission.

Migratory tendencies of the Manchester (Ia.) strain of rainbow trout.
H. M. Ratledge and J. H. Cornell, North Carolina Wildlife Resources Commission.

Control of the water hyacinths and other aquatic vegetation in Florida.
Don Leuthy, Florida Game and Fresh Water Fish Commission.

Preliminary tailwaters investigations.
Don Pfitzer, Tennessee Game and Fish Commission.

Status of commercial and sports fishing on Reelfoot Lake.
Eugene S. Cobb, Tennessee Fish and Game Commission.

The mussel and commercial fisheries in the North Alabama Area of T.V.A.
Larry Miller and Paul Bryan, Tennessee Valley Authority.

Commercial fisheries, their status and use in control of undesirable species. Round table discussion.
Chairman: Spencer Smith, Mississippi Game and Fish Commission.

Review of information on fish shocking devices.
Spencer Smith, Mississippi Game and Fish Commission.

Lake and reservoir clearing. Panel discussion.
Chairman: Parker Smith, Tennessee Game and Fish Commission.

Dingell-Johnson Projects. Panel discussion.
Chairman: Ed Hueske, U. S. Fish and Wildlife Service.

OBSERVATIONS ON GAS-BUBBLE DISEASE OF FISH

R. R. Rucker, U. S. Fish and Wildlife Service, Seattle, Washington
and
K. Hodgeboom, Washington State Department of Game, Puyallup, Washington

SOME DIFFICULTY has been experienced in raising fry and young fingerlings at the Puyallup hatchery of the Washington State Department of Game, a hatchery now in its fourth year of operation. There has been evidence of gas in the yolk-sac fry, and the mortality was always excessive among the fingerlings while reared in the hatchery troughs. The mortality rate decreased and evidence of gas-bubble disease disappeared when the fish were moved to outside ponds. Also, fish seemed less susceptible to parasitic diseases when held in the ponds rather than in hatchery troughs. Strains of fish raised at the station were cutthroat trout (Salmo clarkii clarkii and Salmo clarkii lewisi), rainbow trout (Salmo gairdnerii gairdnerii), and steelhead trout (Salmo gairdnerii iridius).

The hatchery water supply arises from a series of springs. The gas content of the incoming water, determined on samples taken at the head of a trough having the water inlet below the surface of the water, was 80 percent saturation of oxygen and 120 percent saturation of free nitrogen gas. These amounts indicate sufficient oxygen but an excess of nitrogen--20 percent above normal. Under normal operating conditions, the inlet water is introduced into the trough through a half-inch pipe 2 inches above the water surface. By interpolation, the amount of nitrogen gas in the water used for rearing fry at the time difficulty was experienced, was 115 percent or greater. The nitrogen gas content of pond water was 108 percent saturation, as shown in table 1. The ponds (see figure 1) were 5 feet lower in elevation than the hatchery troughs, had a diameter of 44 feet, and received a jet inflow of 125 gallons per minute. The fish were always in much better health when raised in the ponds, probably because the increased aeration reduced the nitrogen gas content.

An experiment to determine the efficacy of aerators on the inlet water gave some interesting results. Aeration devices were set up at the heads of three standard troughs, as shown in figure 2. The water flow used was 8 gallons per minute. There was no difference in the fish raised in water from the devices using a deep box, sprays, or a series of perforated pans, or the regular inlet. The mortality was rather high in all troughs but was attributed to a weak stock of fish, not to gas-bubble disease. The nitrogen content of the aerated waters was 111 percent saturation in all three troughs, whereas the regular trough water had 115 percent saturation. In all determinations made in this study, the oxygen tensions were always satisfactory for fish.

In order to simplify the removal of excess nitrogen, it was decided to agitate (aerate) the water at its source. Figure 3 shows the spring area (in the foreground) which was dammed with the result that the water had a 3.2-foot head over the area below, from which the hatchery water supply is taken. Formerly the 16 second feet of water from the many springs flowed without much agitation to the lower area. Agitation was accomplished by passing the water through a flume 6 feet wide, 4 feet high, 60 feet long, and having three weirs, as shown in figure 3. The saturation of nitrogen gas in the spring area was 124 percent; in a hatchery trough with inlet below the surface of the water, the saturation was 115 percent, which may be compared with 120 percent before the flume was installed (see table 1). The gas content in a normal operating trough was 110 percent saturation of nitrogen when the flume was in operation,

TABLE 1.--Nitrogen gas content of water expressed as percentage at the Puyallup hatchery

	No flume	Flume
Spring	-	124
Hatchery trough inlet below water surface	120	115
Hatchery trough inlet above water surface (normal)	115	110
Aerators	111	-
Pond	108	111

FIGURE 1.--Circular ponds at Puyallup, Washington, hatchery.

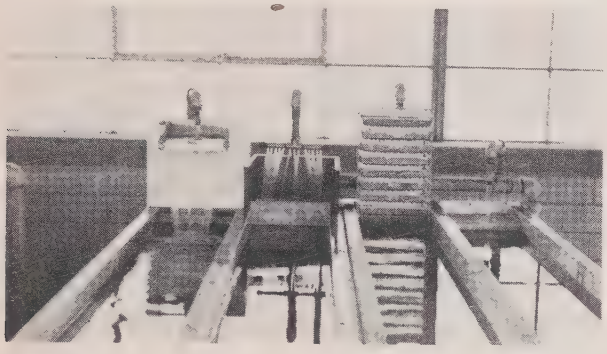

FIGURE 2.--Aeration devices used experimentally at Puyallup, Washington, hatchery.

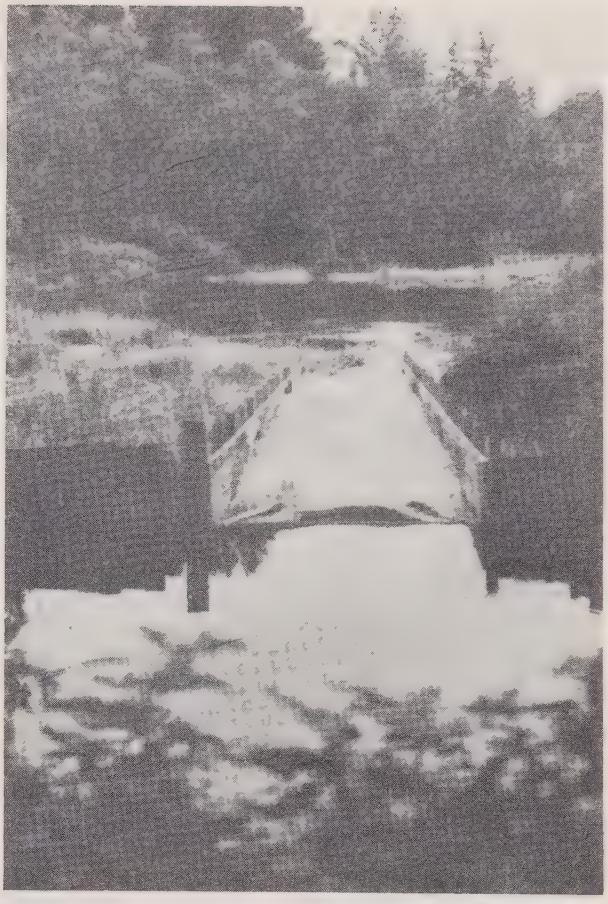

FIGURE 3.--Spring collecting area (in foreground), flume for aerating, and collecting area for hatchery water supply (in background).

whereas the saturation had been 115 percent or greater before the flume was installed. A value of 111 percent for the pond was unexpectedly high: this water was warmer from solarization than the water in the hatchery. Eggs were hatched and the fry were raised successfully in the water in the hatchery troughs after the flume was installed. Fingerling fish were raised successfully in the ponds, and a group of 3-inch rainbow trout transferred from a pond to a hatchery trough for a 7-week period had no significant mortality and showed no evidence of gas-bubble disease. Thus, the evidence indicates that water containing 110 percent saturation of nitrogen gas is satisfactory, but that 115 percent saturation is probably too high for trout.

Gas-bubble disease in fish is characterized by the accumulation of bubbles of nitrogen in the fins, under the skin, and in the vascular system visible in the gills, kidneys, and heart. This disease is similar to man's decompression sickness, which is caused by a too rapid change from a higher to a lower atmospheric pressure. This occurs most frequently among divers and submarine workers when they come to the surface and among occupants of rapidly climbing non-pressurized aircraft. Gas bubbles are formed in the body tissues and fluids. In fish the disease is effected by a higher than normal amount of nitrogen gas in the water at atmospheric pressure. The disease in fish seems to differ from the disease in man by not requiring a great reduction of the nitrogen tension or pressure. The disease occurs in fish when the nitrogen gas pressure in the water is relatively high and apparently constant.

The amount of nitrogen gas that fish can tolerate is of great importance when water supplies are being corrected for this condition. An excess of nitrogen gas is frequently found in spring water, where the oxygen is often below normal, or in pumped water where the nitrogen and oxygen are both high. Gases

in the atmosphere are often forced into water when it is pumped, such action increasing both the oxygen and the nitrogen content.

The effects of altitude and temperature are of great importance in gas studies relating to fish. A saturation of nitrogen determined as 110 percent at sea level would be determined as 134 percent at an altitude of 5,000 feet with the identical nitrogen concentration in the water. A saturation of 110 percent was chosen for this example because we believe that fish can tolerate this excess. A saturation of nitrogen determined as 110 percent at 10° C. (50° F.) would be 121 percent at 15° C. (59° F.), 132 percent at 20° C. (68° F.).

The effect of temperature was demonstrated unexpectedly in the experimental hatchery at the University of Washington a few years ago. We desired to hold some fish at 65° F. in the winter. The entering water was probably just saturated with nitrogen, oxygen, and carbon dioxide. The amount of gas in warm water under normal conditions is less than in cold water. Therefore, water warmed had an excess of gas (an amount greater than it normally would hold at the warmer temperature) enough greater than normal to cause gas-bubble disease.

The conclusion reached from the experimental work at the Puyallup hatchery is that an excess of nitrogen gas of 110 percent saturation in the water is probably not harmful to trout.

RECOMMENDATIONS ON WATER-DEVELOPMENT PROJECTS

As empowered by the Coordination Act of 1934, the Flood Control Act of 1944, and the Coordination Act of 1946, the Fish and Wildlife Service provides assistance to, and cooperates with, Federal, State, public, and private agencies in planning for fish and wildlife on water-development projects. The biologists and engineers of the Service make field examinations in each project area to determine the species, abundance, and value of fish and wildlife, and the probable effect of the proposed construction. State conservation departments, universities, and other sources are contacted for pertinent information.

On the basis of data collected and analyzed, the Fish and Wildlife Service prepares for the construction agencies reports offering many types of recommendations designed either to alleviate losses or to secure benefits to fish and wildlife resources on the areas affected by the proposed construction. Listed below are a few such recommendations with regard to fish, recommendations now being carried out or under consideration.

(1) A fish screen should be included in project plans. Example: Colorado Big-Thompson Project, Colorado.

(2) A subimpoundment with independent water-level control should be constructed to provide more suitable habitat for fish and wildlife. Example: Allatoona Reservoir, Etowah River, Georgia.

(3) In order to protect fish, the reservoir should be operated so as to avoid excessive velocity and turbulence below the dam. Example: Arrowrock Reservoir, Idaho.

(4) A minimum pool of a size specified in the report by the Fish and Wildlife Service should be maintained in the reservoir to protect fishery values. Example: Wishon Reservoir, North Fork Kings River, California.

(5) Fish attractors composed of brush piles secured to bottom of reservoir should be constructed to increase the yield of fish. Example: Belton Reservoir, Leon River, Texas.

(6) The construction agency should encourage the efforts of appropriate agencies in the control of existing and potential pollution in the project area. Example: Osage River Basin, Kansas and Missouri.

(7) Minimum flows specified by conservation agencies should be established below the dam to preserve fishery values. Example: Green and Duwamish Rivers Project, Washington.

(8) Spoil materials from dredging operations should be disposed of in areas where minimum damage to fish and wildlife will result. Example: Housatonic River Navigation Project, Connecticut.

(9) The volume of controllable releases of water from the reservoir shall not be permitted to increase to double, or to decrease to half, of any prevailing discharge in less than one hour during the spawning periods of certain fishes. Example: Roanoke Rapids Power Development, FPC No. 2009, North Carolina.

(10) Low-level outlets should be provided in the dam to assure the release of cool water for fish. Example: Haas Reservoir, North Fork Kings River, California.

WATER SAMPLER AND WATER-ANALYSIS KIT

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MOST FISHERY BIOLOGISTS periodically have the task of analyzing waters of ponds, lakes, or streams while in the field. A simplified sampler for collecting water from depths of approximately 30 feet or less for chemical analysis, and a small portable, greatly simplified chemical kit for the determination of oxygen and carbon dioxide have been developed by the authors. These devices reduce the amount of equipment normally considered necessary, and the results are as accurate as can be obtained by other methods.

Water Sampler

The water sampler pictured in figure 1 incorporates the bottle-train method for collecting water. The train of bottles is connected by a system of tubing that allows the first bottle in the train to be completely flushed twice and to retain the water when filled for the third time. The water in this bottle is then an unadulterated sample from a selected area and is used for the analysis of dissolved oxygen. The middle bottle is flushed once, retaining the water that fills it for the second time; this water is suitable for the analysis of CO_2 from the area. The third bottle is filled only once, and this water should be discarded because it came in contact with the gases present in the unfilled bottles.

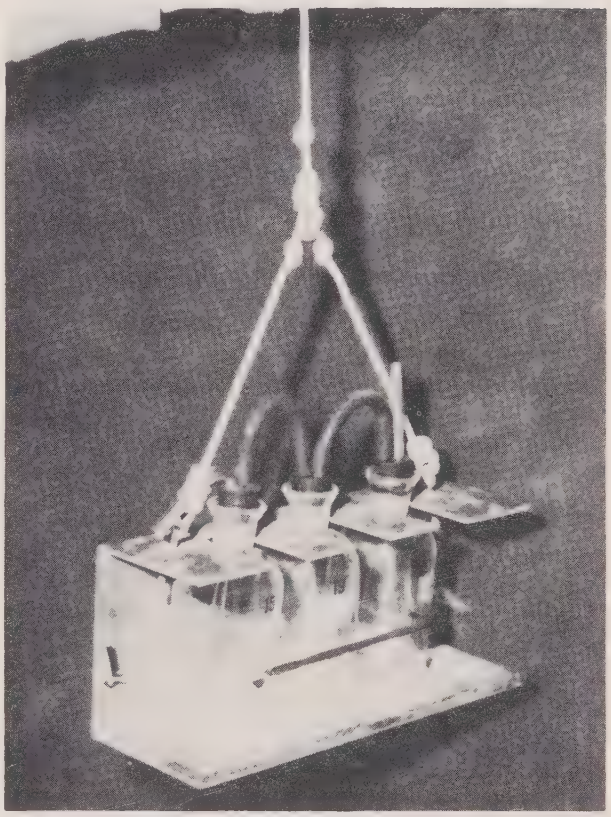

FIGURE 1.--Completed water sampler.

To make the train (figure 2), take three two-hole No. 3 stoppers. Into one hole of each, insert a piece of glass tubing so that it is exactly flush with the small end of the stopper. The tubing should extend just far enough above stoppers 1 and 2 for the attachment of rubber tubing and 4 inches above stopper 3. Into the second holes in stoppers 2 and 3, insert glass tubing long enough to extend from 1/4 inch above the bottom of a B.O.D. bottle to about an inch beyond the top of the stoppers. In stopper 1, this tube should extend far enough above the top of the stopper to be bent so that the open end is turned down and about an inch below the top of the bottle when the stopper is in place. The tubes in stopper 2 are connected with the short tubes in stoppers 1 and 3 by pieces of rubber tubing long enough to allow the stoppers to be placed in three B.O.D. bottles arranged in a row. When the train is in use, water enters through the glass tube that has been bent downward and air is discharged from the long piece of tubing in the other end bottle.

The rack is made from 1/8-inch sheet aluminum 13-1/4 by 11-1/2 inches in size. The metal is bent at right angles along the longer

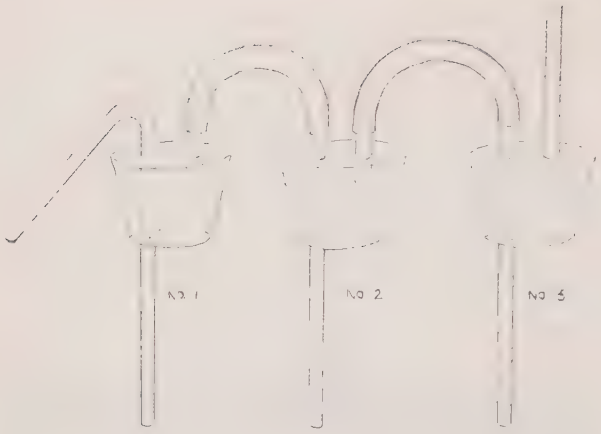

FIGURE 2.--Diagram showing arrangement of tubing and stoppers for the bottle-train method of collecting water for analysis.

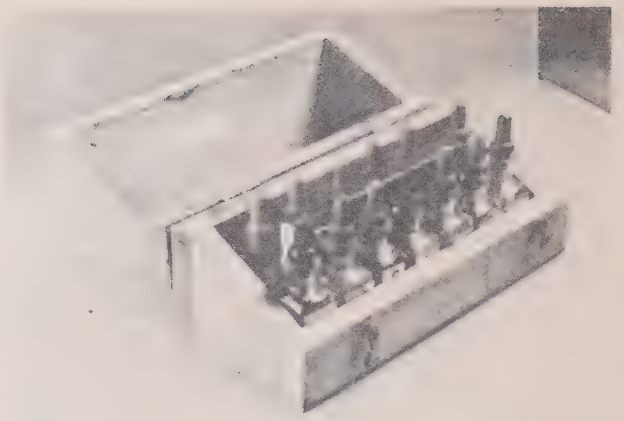

FIGURE 3.--The portable water-analysis kit for determination of dissolved oxygen, carbon dioxide, bicarbonates, and carbonates. The box is 12.5 inches long, 4.5 inches wide, and 4.75 inches high.

side, 4 inches from each end. When the metal is bent in this manner, the device is 5-1/4 inches high--just high enough to allow B.O.D. bottles to be slipped in and out easily. The top of the rack has three slots for the necks of the bottles at intervals that allow the sides of the bottles to touch when in place. There is very little play after approximately 4 pounds of sheet lead is bolted to the base; this weight of lead is adequate to sink the three stoppered B.O.D. bottles rapidly. The bottles are held in place by a piece of rubber tubing: one end is permanently attached to the sampler, and the other end has a string or wire loop that slips on or off a small bolt-hook to facilitate removal and replacement of the bottles.

The hand line is made from a length of plastic clothesline with a wire core and is knotted to provide a good handhold. The first knot is tied 1 foot above the top of the bottles, and the succeeding knots are at 1-foot intervals to calibrate the line. (Six-inch or smaller calibrations may be made by dyeing the line with spirit blue or scarlet red NF dissolved in orthophorone.) The hand line is attached to the sampler by means of a bridle of the same material.

To collect water, fasten the B.O.D. bottles in place with the rubber tubing and insert the train of stoppers. Lower the sampler rapidly to the desired depth by counting the number of knots on the hand line. The cessation of rising bubbles (usually in about 5 minutes) indicates that the bottles are full. Retrieve the sampler. Remove the rubber stoppers and quickly replace with the ground-glass stoppers corresponding in number to each bottle.

Chemical Kit for Oxygen and Carbon Dioxide

The kit equipment needed for oxygen and carbon dioxide determinations: 12 Barnes dropping bottles, 30 ml. capacity, with pipette stoppers; 3 B.O.D. bottles, 300 ml. capacity; 1 tuberculin syringe, B. D. Yale, glass top with plunger of blue glass, 1 cc. capacity, 0.01 cc. subdivision.

These may be purchased from any laboratory apparatus supply store at a cost of approximately $8. In addition, a carrying case (figure 3) should be constructed to hold the tuberculin syringe and the 12 Barnes dropping bottles in two rows of six bottles each.

The three B.O.D. bottles should be calibrated by carefully pouring 200 ml. of water into each and marking the height of the water with a pencil line on the ground glass. This will eliminate the necessity for carrying a volumetric pipette or graduate to measure the volume of the sample to be titrated.

Oxygen Determination

The sulfamic acid modification of the Winkler method is used.

The chemical solutions necessary may be purchased from various chemical supply stores or prepared from C.P. chemicals if accurate laboratory scales and distilled water are available. Chemical solutions necessary are:

A. Sulfamic acid solution: 80 ml. distilled water plus 20 ml. concentrated sulfuric acid plus 4 grams sulfamic acid. Shake until dissolved. Store in the dark.

B. Manganous sulfate solution: Dissolve 480 grams manganous sulfate and dilute to 1 liter with distilled water.

C. Alkaline potassium iodide solution: Dissolve 500 grams sodium hydroxide and 150 grams potassium iodide and dilute to 1 liter with distilled water.

D. Concentrated sulfuric acid.

E. $Na_2S_2O_3$ titre (Standard 0.025 normal sodium thiosulfate solution): Buy already prepared, or make by dissolving exactly 6.205 grams C.P. recrystallized sodium thiosulfate ($Na_2S_2O_3 \cdot 5\ H_2O$) and diluting to exactly 1 liter with freshly boiled and cooled distilled water. If stored in the dark, this standard will remain reasonably accurate for 2 to 3 months. Add 1 ml. chloroform as a preservative.

F. Starch solution: Add 2 grams soluble starch to 100 ml. water. Heat until transparent and add a small grain of thymol for a preservative.

Barnes bottles are marked (figure 4) A, B, C, D, Starch, and $Na_2S_2O_3$ titre, to correspond with the solutions just listed. The pipettes in the Barnes bottles will deliver approximately 0.5 cc. if the rubber bulb is squeezed tightly at each filling, and there is no reason for complete accuracy except in the amount of $Na_2S_2O_3$ titre used. Consequently, the number at the bottom of each bottle label represents the number of pipettefuls of each solution that must be added during the analysis. For the sake of brevity, as well as accuracy, these will be technically referred to as "squirts."

Procedure:

Collect water sample in B.O.D. bottles as directed in the section on water sampler. In the sampler (figure 1), bottle No. 15 (on the left side) would be used for oxygen analysis because this bottle has refilled 3 times. Remove this bottle and immediately insert the glass stopper. Then:

1. Add 2 squirts of solution A. Replace stopper and mix by inverting bottle. Let stand 30 seconds.
2. Add 2 squirts of solution B. Replace stopper and mix by inverting bottle.
3. Add 6 squirts of solution C. Mix by inversion 6 or 8 times. Let stand until the precipitate settles (usually several minutes).
4. Add 2 squirts of solution D. Mix by inversion. The precipitate should dissolve. If it does not, add a little more of solution D and mix thoroughly.

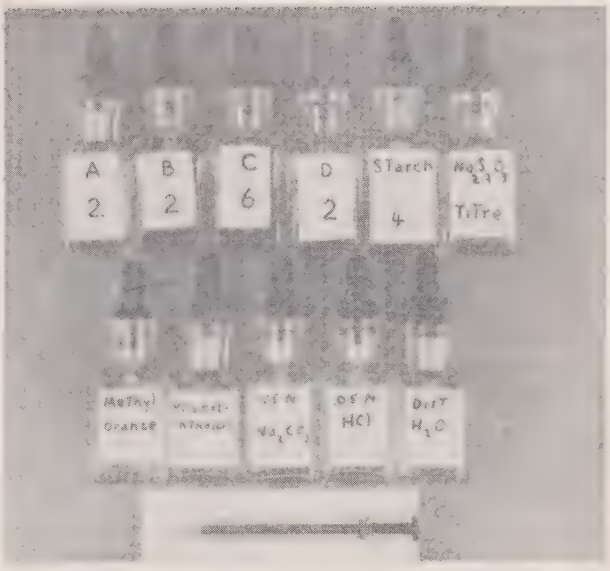

FIGURE 4.--Barnes dropping bottles and tuberculin syringe used in the portable water-analysis kit.

5. Pour out part of the contents of this B.O.D. bottle slowly and carefully down to the pencil line that marks 200 ml.
6. Fill the 1-cc. tuberculin syringe from the bottle marked $Na_2S_2O_3$ titre. Discard this and refill the syringe. Titrate the 200-ml. sample in the B.O.D. until the sample becomes a faint yellow.
7. Add 4 squirts of starch solution and continue the titration with $Na_2S_2O_3$ until the blue color just disappears.
8. Each 1 cc. of $Na_2S_2O_3$ titre used equals 1 p.p.m. O_2 in the sample.
9. Wash out the syringe with distilled water before replacing in the kit.

Carbon Dioxide, Bicarbonates and Carbonates

Most field stations will find it advantageous to purchase the prepared standard 0.05 normal sodium carbonate and 0.05 normal hydrochloric solutions from chemical supply stores.

1. 0.05 N. sodium carbonate: This solution should be purchased in amounts not exceeding 500 ml. and should be kept tightly stoppered in the laboratory. The Barnes bottle in the water analysis kit (figure 3) should be refilled with fresh solution from this supply for each field trip, as this solution takes up carbon dioxide upon exposure to the air. A fresh supply should be purchased each season.

2. 0.05 N. hydrochloric acid: This solution will keep indefinitely in a tightly stoppered bottle. That in the Barnes bottle (figure 3) should be replaced at monthly intervals or oftener.

3. Phenolphthalein solution: Can be purchased already prepared or made as follows: Mix ethyl alcohol and distilled water half and half. Fill Barnes bottle with this mixture, add about 0.2 gram phenolphthalein powder (or the amount that can be held on the tip of a knife point), shake, and label.

4. Methyl orange - Xylene cyanole indicator: Buy the dry powder mixture. Place in a Barnes bottle the amount that can be held on the tip of a knife point, fill the bottle with distilled water, shake, and label.

Procedure:

For the determination of free CO_2, use the middle bottle, No. 19, from the sampler (figure 1). Pour out water carefully down to the 200-ml. pencil line. Then proceed as follows:

1. Add 1 squirt of phenolphthalein. If the solution turns pink, no free CO_2 is present. If the solution remains colorless, proceed with No. 2.
2. Titrate with 0.05 normal carbonate, using the tuberculin syringe, until the solution turns light pink.
3. The number of cc. of the 0.05 N. sodium carbonate used x 5.5 = p.p.m. of free CO_2 in the sample.
4. Wash out the syringe with distilled water before replacing in the kit.

For the determination of bicarbonate and carbonates, the water in the B.O.D. bottle on the right in the sampler (figure 1) may be used. This bottle has been filled only once, but this will have little effect upon the bicarbonate and carbonate content of the water. Pour out water carefully down to the 200-ml. pencil line. Then proceed as follows:

1. Add 1 squirt of phenolphthalein.
2. If the solution remains colorless, practically no carbonates are present. In this case, continue with step 4.
3. If the solution above becomes pink, titrate, using the tuberculin syringe, with 0.05 N. hydrochloric acid, adding a drop every 2 to 3 seconds until the pink color disappears. Record the cc. of 0.05 N. HCl as P (phenolphthalein alkalinity).
4. To the water sample from either step 2 or step 3, add a few drops of methyl orange - xylene cyanole.
5. Titrate, using tuberculin syringe, with 0.05 N. HCl to the end point (gray color). Record the cc. of 0.05 N. HCl required as M (methyl orange alkalinity).
6. Calculation:

a. If M = 0 cc., P represents OH alkalinity; P (cc. of 0.05 N. HCl) x 10 = p.p.m. OH alkalinity as NaOH.

b. If M - P = 0, then no bicarbonates are present and titration represents carbonates. P (cc. of 0.05 N. HCl) x 15 = p.p.m. CO_3^{--} in sample.

c. If M - P = X cc., then:

P (cc. of 0.05 N. HCl) x 15 = p.p.m. CO_3^{--} in the sample; (M - P) or X (cc. of 0.05 N. HCl) x 15.25 = p.p.m. HCO_3^- in the sample.

"Our studies suggest that brook trout are more desirable than the brown or rainbow for New York ponds primarily because they are short-lived and most vulnerable to angling. The principal drawback of the rainbow is its spring spawning habit, resulting in poor condition of the fish for spring fishing.

"Stocking rates have varied from 150 to 600 fingerlings per surface acre of water. Three hundred is accepted at present as a reasonable figure for most conditions, although it is evident that ponds vary considerably in their carrying capacities. Little difference in survival for a six month period is apparent between spring versus fall fingerling plantings ...

"Estimates of survival at approximately 6 month intervals for the various ponds have been made with bag seines up to 150 feet long, using the marking and recovery method described by Ricker ... Confidence limits for these estimates are narrow because the ratio of marked to unmarked fish is high (approximately 0.5) and the samples large."

--From "Some Results of Farm Pond Management Studies in New York," by Saul B. Saila, Journal of Wildlife Management, July 1952.

MORTALITY OF SILVER SALMON FROM TREATMENTS WITH SULFAMERAZINE

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IN THE SPRING OF 1951, a bacterial infection caused heavy mortalities among silver salmon (Oncorhynchus kisutch) fingerlings reared at the Dorena Dam Experimental Laboratory of the Fish and Wildlife Service at Cottage Grove, Oregon. The etiological agent was tentatively identified as a type of myxobacterium which caused severe external lesions on the affected fish. Treatment with sulfamerazine administered in the feed at the rate of 6 grams of drug daily for each 100 pounds of fish to be treated, was initiated after the epizootic was well established. Soon after the treatments were started, there was a sharp drop in mortality and noticeably fewer fish had lesions characteristic of the disease. Three days after this reduction in losses there was a sudden rise in the daily mortality, but the fish at this time rarely had any of the characteristic lesions or any apparent reason for death. Sulfamerazine was suspected to be the cause of this renewed upsurge in mortality, and treatments were discontinued. It was necessary to plant most of the fish in the lot before any conclusions could be reached, but a few of the salmon were retained for further experiment.

The experiment was conducted in two standard deep troughs. Each of these contained 500 fingerling silver salmon, all of which had been fed sulfamerazine at the 6-gram rate for the previous 14 days. At the start of the test on May 18, these fish were about 3 months old and averaged 2.7 grams (168 fish per pound) in weight. Their weight had increased to 5.0 grams (91 fish per pound) when the experiment was closed on June 28.

No treatments were given to the fish in trough 1 for the first 2 weeks of the experiment, during which time the mortality dropped to normal (table 1). Sulfamerazine was again fed to these young salmon during the third and fourth weeks of the test, resulting in a rapid rise in mortality in the fourth week. In the final 2 weeks, no drug was administered and the mortality again returned to normal. The silver salmon in trough 2 were fed sulfamerazine for the first 2 weeks of the experiment, and the losses continued to be high. At the start of the third week the drug was withdrawn from the diet for this trough of fish, and after 4 days the mortality in it had dropped to zero. Only one more fish was lost in this trough before the experiment was concluded at the end of the sixth week. While the test was in progress, the maximum daily water temperatures ranged from 49° to 54° F., averaging about 51° for the period.

During the spring of 1952 an experiment was conducted with fingerling silver salmon which had no disease nor previous treatment. These fish were 2 months old and averaged 0.9 gram (500 fish per pound) when the experiment was started. The fish averaged 2.1 grams (215 fish per pound) 5 weeks later at the close of the test.

On May 4, 250 silver salmon were placed in each of eight troughs which were approximately 4 feet long and 1 foot wide. The fish in troughs 1 and 2 were the control group and were given no disease treatments during the 5-week experiment. The fingerling salmon in troughs 3 and 4 were fed sulfamerazine at the 12-gram rate during the first week, at the 6-gram rate in the second week, and no drug thereafter. The fish held in troughs 5 and 6 were fed sulfamerazine at the 12-gram rate during the first 3 weeks. The silver salmon in troughs 7 and 8 received the drug at the 6-gram rate for the first 3 weeks of the test.

Mortalities in all troughs during the experiment are shown in table 2. It is apparent that the sulfamerazine was toxic to the young silver salmon, as there were high mortalities in all troughs of fish fed the drug and there were no losses in the troughs of control fingerlings. The mortalities first developed during the second week of treatment and disappeared soon after the drug was withdrawn from the feed. Mortalities increased with both length and rate of treatment. Losses from 3 weeks of treatment at the 12-gram rate were almost double the losses in the group of salmon treated at the 6-gram rate for 3 weeks.

TABLE 1.--Mortality and sulfamerazine treatments of silver salmon in an experiment conducted May 18 to June 28, 1951

[All fish previously treated with sulfamerazine for 2 weeks; 500 fish per trough at start]

Trough and treatment		Weekly period 1	2	3	4	5	6	Total mortality	Percent mortality
Trough 1	mortality--	3	1	0	49	20	0	73	14.6
Sulfa rate	grams--	None	None	6	6	None	None		
Trough 2	mortality--	28	78	25	0	1	0	132	26.4
Sulfa rate	grams--	6	6	None	None	None	None		

Three weeks of treatment at either the 6- or the 12-gram rate resulted in mortalities higher than those in troughs of fish treated 1 week at each rate. The maximum daily water temperatures ranged from 49° to 58° F., averaging about 54° during this experiment.

In 1951 and in 1952, sulfamerazine was used in the treatment of columnaris disease in fingerling silver salmon in July and August. Though the drug was fed continuously at the 6-gram rate for periods as long as 4 weeks in 1951, there was no indication that sulfamerazine was toxic to the salmon. Starting in July 1952, sulfamerazine was fed 6 days weekly at the 6-gram rate to silver salmon fingerlings for 11 weeks, with no evidence of toxicity to the fish. The fish were larger than in the previous experiments, averaging about 6 grams (76 fish per pound) at the start of treatment in 1951 and 7 grams (65 fish per pound) in 1952. The water was also much warmer, as daily maximum temperatures during the period of treatment ranged from 70° to 73° F. in 1951 and from 65° to 73° F. in 1952.

These experiments and observations did not furnish positive evidence of the reasons for the differences in mortality resulting from the use of sulfamerazine on fingerling silver salmon in the spring and in the summer, but it appears probable that either the larger size of the fish or the warmer water or a combination of these factors accounts for the absence of any adverse effects from treatments with the drug during July and August.

Conclusions

To fingerling silver salmon averaging 1 to 5 grams in weight and reared in water having maximum daily temperatures of 49° to 58° F., sulfamerazine was toxic when fed for 2 or more weeks at the rate of either 6 or 12 grams of sulfa daily for each 100 pounds of fish treated.

To fingerling silver salmon more than 6 grams in weight and reared in water having maximum daily temperatures over 65° F., sulfamerazine was apparently not toxic when fed at the 6-gram rate for periods of 6 and 11 weeks.

The exact limits of fish sizes and water temperatures at which sulfamerazine is no longer toxic to silver salmon were not determined. The drug should be used with caution under all conditions.

TABLE 2.--Mortality and sulfamerazine treatments of silver salmon in an experiment conducted May 4 to June 7, 1952

[250 fish per trough at start]

Trough and treatment		Weekly period 1	2	3	4	5	Total mortality	Percent mortality
Trough 1	mortality--	0	0	0	0	0	0	0
Trough 2	do--	0	0	0	0	0	0	0
Sulfa rate	grams--	None	None	None	None	None		
Trough 3	mortality--	1	15	22	0	0	38	15.2
Trough 4	do--	0	9	18	0	0	27	10.8
Sulfa rate	grams--	12	6	None	None	None		
Trough 5	mortality--	0	28	67	3	0	98	39.2
Trough 6	do--	0	25	73	2	0	100	40.0
Sulfa rate	grams--	12	12	12	None	None		
Trough 7	mortality--	0	8	39	1	0	48	19.2
Trough 8	do--	0	6	44	2	0	52	20.8
Sulfa rate	grams--	6	6	6	None	None		

A MACHINE FOR SOUNDING AND FOR OPERATING LIMNOLOGICAL APPARATUS

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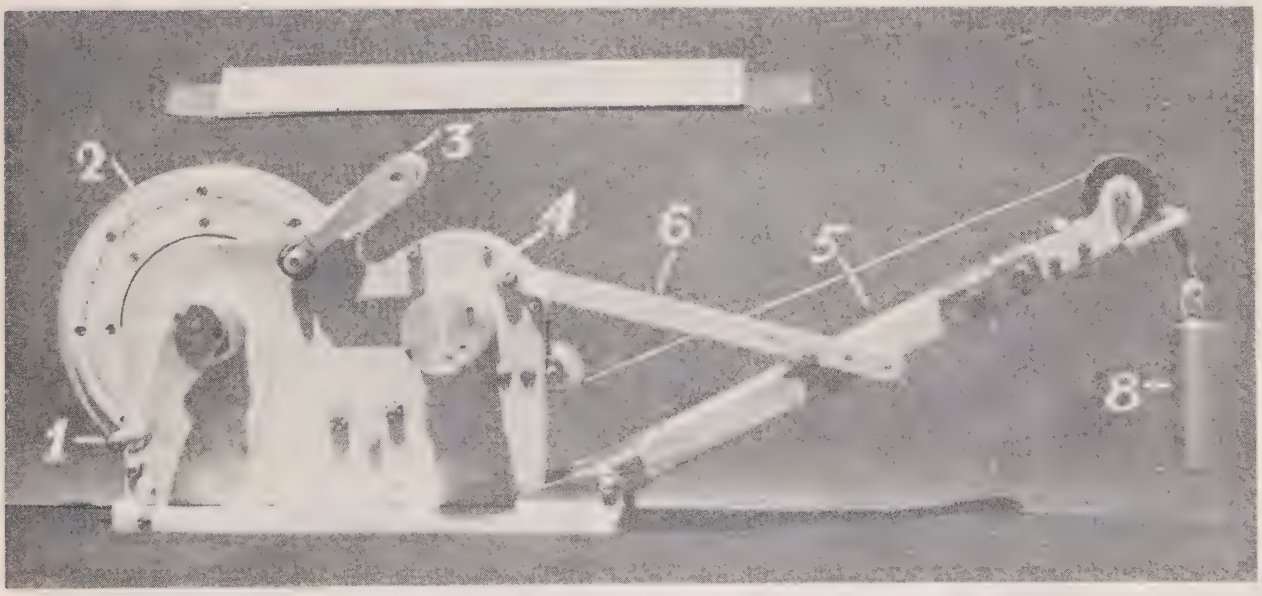
TO FACILITATE the collection of large amounts of limnological data during recent research on lakes of Convict Creek Basin, California, fishery research biologists of the Fish and Wildlife Service have designed this new type of sounding and line-handling machine (see photographs). Essentially it is a depth-recording device, but it may be used with equal facility with a variety of equipment including plankton nets and traps, Ekman dredges, Kemmerer water samplers, and reversing thermometers. It has great advantages of speed and accuracy over the standard graduated workline and is particularly well adapted for use in making vertical plankton hauls where slow, steady, and perfectly controlled retrieves are essential.

Construction of the instrument is entirely of noncorrosive materials (wood, aluminum, brass, and stainless steel), and sealed ball bearings are used throughout. The aluminum line-storage reel holds 400 feet of 1/16-inch

Sounding and line-handling machine: at left, with Ekman dredge; below, with 15-inch ruler. Features: (1) crank; (2) reel showing brake surface; (3) spring-clip brake; (4) Veeder-Root counter; (5) adjustable boom at 15 inches, extensible to 31; (6) adjustable boom brace; (7) sounding weight with soil-sampling cone attached; (8) sounding weight with soil-sampling cone detached.



cable, and the gear ratio is such that 2 feet of cable are retrieved with each revolution of the crank. A spring-controlled brake permits slowing or complete stopping while paying out line and is sufficiently strong to hold a fully loaded Ekman dredge. The cable runs over a pulley of 1-foot circumference, and the revolutions of the pulley are recorded on the four-place Veeder-Root counter. Depth of terminal equipment is obtained simply by reading the counter. An idler wheel holds the cable in contact with two pulleys, eliminating slippage and preventing jumping of the cable. A hardwood boom, adjustable from 15 to 31 inches in length and adjustable in vertical angle, permits mounting in boats of various sizes and types. The guide-pulley at the end of the boom is deeply grooved and holds the cable securely in moderately rough water. For carrying in the case, the crank handle and boom are detached, but only about 2 minutes are required to assemble these parts and make the machine ready for use. Accessories include spare pulleys, one spare Veeder-Root counter, tools, and a stainless-steel sounding weight equipped with a detachable soil-sampling cone.

The workline that is used in the machine is flexible, easily handled, has a breaking strength of 270 pounds, and has no significant stretch (about 0.3 inch in 400 feet) when used with weights to 40 pounds. There is obviously no problem of stretch or shrinkage, and line of this small diameter and weight is excellent in deep water for "feeling" the nature of the bottom while making soundings. The terminal end of the line has a bound and soldered loop for attaching light apparatus equipped with safety snaps. Heavier equipment, such as an Ekman dredge, is attached by means of a short, threaded sleeve that is positioned on the line above the loop. This sleeve is run through the attachment opening of the equipment and is secured by two locking nuts.

The machine was designed for general limnological work on shallow to moderately deep lakes, in situations where minimum weight, compactness, and complete portability are essential. The carrying case measures 16 by 11 by 7½ inches. The weight of the entire outfit, including case and all accessories, is 25½ pounds; ready for use, the machine weighs 14 pounds. The machine can be clamped to seats or cowls of small boats, bolted to a sheet of plyboard and mounted on an air-filled rubber boat, or secured to the rail on larger craft.

Although this machine is not expected to be generally available, inquiries about it may be directed to: Convict Creek Experiment Station, U. S. Fish and Wildlife Service, Route 3, Box 36, Bishop, California.

STUDY OF GRAYLING ON GREBE LAKE

Grebe Lake in Yellowstone National Park is the home of a splendid population of Montana grayling. As this lake is also used now by rainbow trout, the Fish and Wildlife Service has begun a study to determine the relationships between the rainbow and the grayling--particularly the degree of competition for food, spawning ground, and space. Where the two species share a water, information of this type is all-important to the preservation of the grayling.

The preliminary work completed in 1952 included studies of spawners--counting, measuring, sexing, weighing, and taking scales; preparation of a map at 3-foot contours; the collection of 100 bottom samples; tagging operations in preparation for a population estimate and for growth data; the collection of physical and chemical data from the lake and tributaries; observations on immature fish in the lake and streams; and a creel census during the 2 weeks that Grebe Lake was open for fishing. Programs planned for the next two summers are expected to provide sufficient information for the National Park Service's regulation of the fishery.

"From my experience I am satisfied that one inch of water from forty-eight to fifty-two degrees, with proper care and fixtures, will hatch a hundred thousand trout, and grow in good health sixty thousand one year."--Letter from Stephen C. Ainsworth to the U. S. Commissioner of Agriculture, Report of 1868.

CHLORETONE AS AN ANAESTHETIC FOR ADULT CUTTHROAT TROUT

Oliver B. Cope
U. S. Fish and Wildlife Service
Logan, Utah

THE USE OF CHLORETONE by Roger E. Burrows for anaesthetizing salmon fingerlings at the Salmon Cultural Laboratory of the Fish and Wildlife Service at Entiat, Washington, has been noted in The Progressive Fish-Culturist for April 1952 (volume 14, number 2, page 78). Burrows has secured good results by suspending a net containing fingerling salmon in a 1:2,500 concentration of the chemical until the swimming motion of the tail has ceased and the fish lie on one side. At this point the fish are considered anaesthetized and they may safely be handled for measuring. When measurements have been completed and the fingerlings have been placed again in fresh water, 3 to 8 minutes are required for recovery from the anaesthetic.

Chloretone (chlorobutanol; trichloro tertiary butyl alcohol) was used successfully as an anaesthetic for adult cutthroat trout (Salmo clarkii lewisi) on Yellowstone Lake during the summer of 1952. Anaesthesia was desired as part of a tagging program, and the chemical that had been used in previous years (urethane; ethyl carbamate) was not available in sufficient quantity. It was decided to substitute chloretone in a few trial treatments, and the results in this experimental work were so successful that use of the chloretone was continued during the remainder of the season. As far as is known here, this work at Yellowstone Lake represents the first application of chloretone as an anaesthetic for cutthroat trout.

In practice, a stock solution of chloretone was prepared in the laboratory prior to use in the field. This preliminary preparation of the stock solution was essential because of the difficulty with which chloretone crystals were dissolved in cold water in the field. Ten grams of the chloretone crystals were dissolved in 1 liter of warm water to make the stock solution, the concentration of which was 1:100. It was found that any excessive heating of the water should be avoided, because the effectiveness of the anaesthetic was considerably diminished when much heat was applied. The liter of concentrate was then taken into the field and diluted until the volume of concentrate was 20 liters, when the strength of the chloretone solution was 1:2,000. The results obtained with the stock solution indicated that this strength was suitable for anaesthetizing cutthroat trout in Yellowstone waters at temperatures between 35° and 55° F. It is possible, of course, that other waters and other fish may require the preparation of concentrations quite unlike that employed at Yellowstone.

In the procedure worked out at Yellowstone, the anaesthetic was administered by placing 12 to 15 adult trout in a tub that contained the 1:2,000 solution. The fish turned over in the tub within 1 or 2 minutes and were then in condition for the handling that was unavoidable during tagging, measuring, weighing, and taking of scale samples. As soon as each fish had been processed, it was placed in a live car in fresh water. Here recovery from the anaesthetic occurred within 2 to 10 minutes, the time required for this recovery depending upon the length of time the individual fish had been exposed to the chloretone.

Comparisons between chloretone and some other anaesthetics which are used on fish make the chloretone show up very favorably. The program at Yellowstone Lake has included much use of urethane, and this use has permitted fishery workers to form some impressions concerning the comparative performances of chloretone and urethane. First, chloretone is effective in lower concentrations than urethane. Second, the lasting powers of the mixed solutions of the two chemicals appear to be about equal. Third, urethane is easier to use than chloretone because the preparation of a stock solution is not necessary for the former.

The chloretone used at Yellowstone cost $4.50 per pound in 1952; the last urethane purchased in 1952 cost $4.27 per pound.

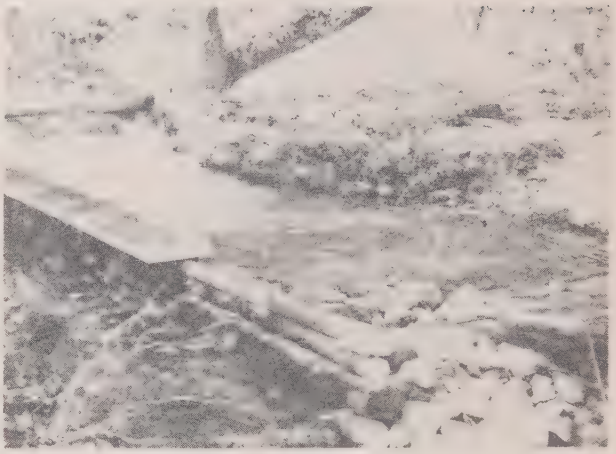
A NEW TYPE OF FISH TRAP

Reed S. Nielson
U. S. Fish and Wildlife Service
Reno, Nevada

FISH-CULTURISTS and fishery biologists engaged in work with trout frequently find it necessary to construct devices in streams to trap spawning runs in order to take eggs, to enumerate runs, to tag individuals for population studies, and for other purposes. Such construction usually involves the installation of a conventional picket-section trap with upper and lower weirs enclosing a catch basin. The lower weir is designed to concentrate flow and to permit the passage of fish into the catch basin through a V-type opening. Although this type of trap has great versatility and is quite successful, it nevertheless requires considerable surveillance to keep the picket sections sufficiently free of debris to assure proper functioning and to prevent the loss of the structure. This is particularly true in the fall and early in the winter, when streams are heavily burdened with leaves and debris and low temperatures cause the formation of ice.

This type of installation was used to trap the spawning run of brown trout from Convict Lake, California, during the fall of 1951. At the conclusion of this operation it was certain that the expenditure of time and effort required to keep the trap free of debris and functioning did not fully compensate for the results obtained. The situation indicated clearly that a change in trap design would be necessary before any future work could be attempted.

A careful review of the observed behavior of brown trout in 1951 indicated that they, like other salmonids, require a pool or at least a foot of water from which to leap in order to clear obstructions in their upstream progress. Accordingly, a structure that would deny them this opportunity and at the same time eliminate the necessity for cleaning was designed and constructed in the inlet stream to Convict Lake in September 1952. Gross construction features of this trap are shown in the drawing (figure 1). It, like the conventional picket-section structures, consists of upper and lower barriers enclosing



a trap or catch basin. The great difference lies in the fact that this installation uses no picket-sections and consequently requires no cleaning.

The upper barrier (see section A-A) is constructed of logs and 2x12 planks. Three logs of sufficient length to span the width of the stream and to extend into the banks at each end for 3 or more feet were used. The upper log (1) was placed in a level position approximately 2 feet above stream water level, and its ends were securely anchored in the stream banks with rocks and boulders. The two lower logs, (2) and (3), were dug into position slightly below stream-bed level, 5 feet apart and levelled; the downstream log was placed 2 inches lower than the upstream log. The ends of these logs were also dug into the stream banks and weighted with rocks and boulders. These logs formed the beams for the 2x12 plank apron that was nailed to them. Planks (2x12) 2 feet in length were then nailed in vertical position to the upstream apron log and to the log above the stream surface to form the dam. The entire flow of the stream passes over this dam in a layer of uniform thickness which spills onto the gently sloping apron and forms a perfect barrier to the upstream progress of fish.

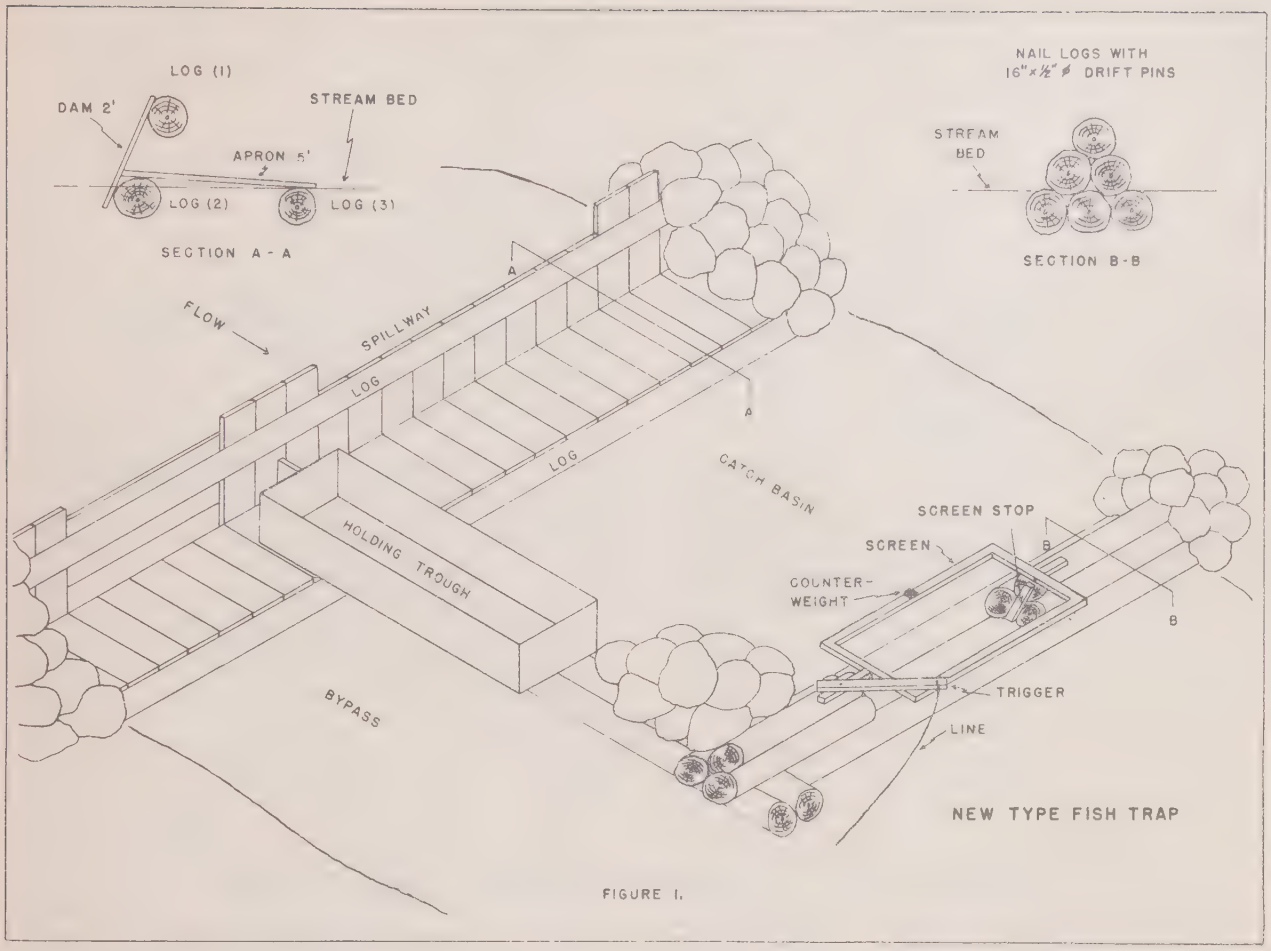
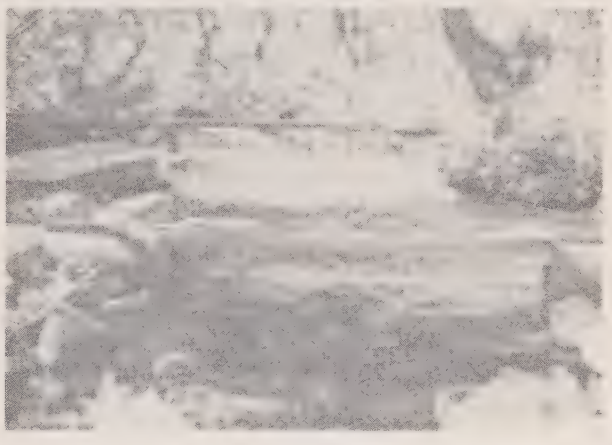


FIGURE 1.

A pyramid log dam (see section B-B) that is anchored with rocks and boulders forms the lower barrier. To concentrate the flow and to permit the passage of fish into the catch basin, an opening 64 inches wide was cut through this dam and framed to accommodate a screen. The 2x4-framed screen, covered with mesh (2x2) hardware cloth, measures 30 inches by 64 inches. It is placed in a hinged or pivot position in the opening with steel pins (1/4-inch diameter) driven through the short sides (30 inches) at the midpoint (15 inches) and into short lengths of 2x4 nailed to the tops of the logs that form the opening. A



small counterweight attached to the upstream edge of the screen is sufficient to cause it to rotate from horizontal to vertical position and thus close the trap opening. Operation of the screen is accomplished by means of a trigger device operated by trap attendants. This device consists of a short length of 2x4 nailed in position on the top log so that its free end can be pulled over a downstream corner of the screen frame to hold it in a horizontal position and leave the opening free to the passage of fish. A long line is attached to the free end of the 2x4, and a slight pull is all that is necessary to release the screen and close the catch basin.

These are the essential features of the trap. However, to facilitate the handling of fish at Convict Creek, certain refinements were added. These consist of a bypass and a screen-covered trough for holding fish. The bypass was formed by placing logs between the upper and lower barriers, parallel with the current, at a point approximately one-third the width of the stream. The flow into the bypass is controlled by means of horizontal dam boards placed across an opening in the head dam. The holding trough is mounted on top of the bypass logs and is supplied with water from the crest of the dam by a small flume.

In operation, an attendant walks upstream to the trap and releases the trigger device; the screen turns from the horizontal to the vertical position, closing the trap; next an attendant removes horizontal dam boards to the bypass, reducing or cutting off the flow into the catch basin; and trapped fish are netted from the catch basin and placed in the holding trough for further handling.

This trap, like all others, has its limitations, but it is capable of many adaptations. It is, however, certainly suitable for use in streams comparable to Convict Creek. Convict Creek has an autumn flow ranging from 20 to 35 cubic feet per second and has an average width of 20 feet at the trap site. The banks of the stream are rather low and they limit the height of the upper and lower barriers.

Total cost of the installation, exclusive of labor, was $75.

PONDFISH PRODUCTION: DIFFERENCE IN PURPOSE AND UTILIZATION

It has been estimated that ponds in some areas of the United States produce about 175 pounds of fish per acre annually. There is a tendency to apologize for low productivity, as indicated by this figure, when reference is made to the pounds-per-acre production of South China (4,000), Malaya (3,500), Hong Kong (2,000 to 4,000), Palestine (1,200), and the Philippines (450 to 900).

It should not be overlooked that in the United States the culture of pond fishes has been undertaken primarily to provide recreational fishing, nor that emphasis in this country has been largely upon such species as the largemouth black bass, the bluegill, and the catfishes. By contrast, most of the areas that have reported the greatest productivity have also placed emphasis upon the propagation of fish for food and other commercial usage.

Within the last few years the farm fishpond has gained widespread recognition in the United States as a valuable source of food, but the pond is still highly regarded also as a source of relaxation. Few of the anglers in this country would fully approve and appreciate the intensive development and commercialization of the ponds described by S. L. Hora, Director of the Zoological Survey of India, in his paper entitled "Pond Culture of Warm-Water Fishes," presented at the United Nations Scientific Conference on the Conservation and Utilization of Resources in 1949:

"Under the term 'pond', I have included small occasional ditches as well as impounded waters several hundred square miles in extent and several hundred feet deep. Small ditches can be used as nurseries while large reservoirs could serve as perennial sources of fish-supply. If run on a co-operative or collective basis, all the ponds in a village can be utilized as one productive unit. Besides the production of food, such collective fish-farms can utilize fish-wastes for the manufacture of oil from liver and entrails, glue from scales and fish-meal from bones, etc. Residual fish-wastes are good fertilizers for fruits, vegetables and crops. Bottom-silt, containing organic debris, which must be removed occasionally for the sanitation of ponds, is also a good manure."

COMMENTS

MICHIGAN DEPARTMENT OF CONSERVATION
Pigeon River Trout Experiment Station
Vanderbilt, Michigan
October 15, 1952

The Editors
The Progressive Fish-Culturist
U. S. Fish and Wildlife Service
Washington 25, D. C.

Dear Sirs:

I have read the paper by Ratledge and Cornell entitled "The Effects of Trout Stocking on the Rate of Catch," that appeared on pages 117-121 of the July issue (volume 14, number 3) of The Progressive Fish-Culturist. This is a very interesting paper, although I am not able to go along with some of their recommendations.

I think the authors' interpretations of trout stream dynamics were handicapped by lack of what I like to call "experimental control" of the entire investigation. There were no population estimates of the different streams, no idea of recruitment into catchable-sized fish, and not even the possibility of sorting hatchery returns from wild production. I do not see how they are able to make the rather sweeping conclusions they do, based upon so few data. For instance, "It appears that the catch rate is much more greatly affected by the number of fishermen on the stream than by the number of fish in the stream." Since the rate of catch is a function of both the fishing pressure and fish population density (especially of brook and rainbow trout), it is possible to manipulate the catch per hour almost at will by planting appropriate numbers of fish. We can demonstrate such a relationship quite definitely from our work here. Their conclusion that "It appears, then, that an average catch of 1.1 fish per man hour by all fishermen and under all circumstances is the best that can be obtained in these streams--even by excessive stocking" does not make sense. Duplicate the population density in one of those streams similar to a hatchery pond and see what the catch per hour is. In Dr. D. S. Shetter's (Michigan) hooking experiments using hatchery brook trout, it was common to average 15 to 20 trout per hour during the first few hours of each run. By that time, if all fish had been kept, recoveries of more than 50 percent would have been possible.

I cannot go along with many fishery men who minimize the value of stocking legal-sized trout for immediate recapture. Admittedly it is expensive, and perhaps fishermen as a rule are unwilling to pay for it. But it is one management tool that can be demonstrated to be effective in producing results. I think we must realize that the greater portion of the people who fish for trout couldn't catch one if you threw it at them, but they can catch planted brook trout and they do like it. A realistic program of small plantings at frequent intervals in sections of streams that lack suitable or adequate spawning facilities for native trout has a definite place in trout-stream management in Michigan or elsewhere where fishing pressure is heavy. In addition, Michigan is experimenting with another method of producing good fishing. In this, portions of good trout streams are set aside for fishing for recreation only. The experiment on the North Branch of Au Sable River (Michigan) has demonstrated that unbelievably good fishing can be had for native brook trout of practically any size you want if you are willing to release what you catch. The two different types of fishing cater to two definite types of fishermen, and both deserve some consideration.

Sincerely,

Edwin L. Cooper

Since writing this letter, Dr. Cooper has accepted the position of Chief Aquatic Biologist, Wisconsin Conservation Department.

When Ratledge and Cornell submitted this paper, they pointed out in their letter of transmittal most of the weaknesses mentioned in Dr. Cooper's letter. We accepted the

paper because we hoped that it would provoke some comment, and because it presented four points indicating a new trend in trout fishery management. These points were as follows: (1) creel censuses may be misleading if results obtained from one body of water are applied to other waters; (2) stocking is not essential in streams producing a good native trout population if fishing intensity is not excessive; (3) the natural population of a good trout-producing water supports a large part of total catch; (4) fishing pressure is not evenly distributed, and small streams and streams off the "beaten track" are not fully utilized.

We also believe that, because of longer growing season and other peculiarities, the trout streams in the Southeast are different from those in the rest of the United States and cannot necessarily be compared with other streams.--The EDITORS

U. S. DEPARTMENT OF THE INTERIOR
Fish and Wildlife Service

November 13, 1952

Memorandum
To: Editors, The Progressive Fish-Culturist
From: Willis King, In Charge, Section of Fish Investigations, Branch of Federal Aid

The picture of trout management presented by Hayden Ratledge and Harry Cornell in The Progressive Fish-Culturist for July 1952 in their paper, "The Effect of Trout Stocking on the Rate of Catch," is a stimulating one that should arouse some fisheries managers from their professional lethargy. Knowing a little about the waters described and also having had opportunity to see what goes on on the other side of the mountain, I cannot resist comment on the ideas presented. The North Carolina workers have given a clear statement of the problem. I cannot agree with some of the conclusions stated in the North Carolina report, particularly No. 6, because I do not believe it possible to measure the contribution of hatchery fish to a catch when these are stocked without recognition mark and are added to an unknown natural trout population. As the subject is pursued, gradually the pieces of the puzzle should come together so that trout stocking programs can be fitted to the level of a reasonable return on the dollar invested.

Catch records alone cannot reflect the return of the stocked fish to the creel, their survival from month to month, the extent of "depletion" of stream-produced fishes, and the rate of recruitment within the native population into creel-sized trout. All these things are important knowledge in planning a trout management program. The conclusion that "the number of fish in the stream was not a limiting factor on fishing success" can hardly be accepted without qualifications. The stream referred to, Santeetlah Creek, is considered an excellent trout stream and has supported good fishing over the years. The authors' statement might be expected to hold true as long as fishing pressure remained relatively light and the native trout population continued to supply goodly numbers of catchable-size fish. Certainly there are limits within the influence of both of these conditions, above or below which the anglers' success would not remain the same.

To gain light on this important question, let us look at information gathered on the other side of the mountain. The streams in Great Smoky Mountains National Park are very similar to those of the Pisgah and Nantahala National Forests. A creel census was taken on one of the Park streams during 1950, the same period as that reported in the paper under discussion. The stream was Little River above Elkmont, in Tennessee, where approximately 12 miles of fishable trout waters were available to the angler, with 10 miles of smaller tributaries that contained native brook trout but were too small and rough to fish. The only trout stocked were 500 eastern brooks, 8 to 12 inches in length, placed in the stream before the fishing season and marked by clipping the right ventral fin. These fish were readily distinguished from the native brook trout. The dominant trout in the fishable

TABLE 1.--Fishing returns, Little River, Great Smoky Mountains National Park, 1950 season[1]

Period	Fisherman days	All brook trout	Marked brook trout	Rainbow trout	All trout	Average creel
May 16-31	546	284	258	2,598	2,882	5.3
June 1-15	309	61	18	1,436	1,497	4.8
June 16-30	394	80	14	1,746	1,826	4.6
July 1-15	310	73	9	1,342	1,415	4.6
July 16-31	266	67	3	1,318	1,385	5.2
Aug. 1-15	268	113	3	1,223	1,336	5.0
Aug. 16-31	374	118	1	1,641	1,759	4.7
Totals	2,467	796	306	11,304	12,100	4.9

[1] From a paper presented at the Conference of Southeastern Game and Fish Commissioners at Richmond, Va., Oct. 15-18, 1950, by Willis King and Warren Currier. The paper is in the files of the Tennessee Game and Fish Commission and the Nat'l Park Service.

waters is the rainbow. No rainbows were stocked in 1949 or 1950, so all rainbows can be regarded as stream-produced. The creel census was almost 100 percent complete, with an attendant on duty at all times fishermen were on the stream. The accompanying table tells the story. The stocked brook trout showed up heavily in the first 2 weeks of the season, with half of them removed by anglers during that period. At the same time, however, the brook trout were outnumbered by the rainbows 10 to 1. If we remove the hatchery brooks from the picture, the average creel for the first 2 weeks drops 0.5 to 4.8 fish per fisherman day, which is almost the same as the season average. Certainly the stocking contributed little toward anglers' satisfaction in this instance. The important point is that 200 fishermen per mile on Little River did not deplete the natural trout population enough to be reflected in decreased fishing success as the season advanced. With heavier fishing pressure or a smaller native population, the returns could well have been different.

Let us look at another example where hatchery fish did make a material difference. The Tellico Wildlife Area, also in Tennessee, lies just across the State line from North Carolina's Santeetlah Wildlife Management Area. The streams are comparable in size, but, in 1950, 7,429 anglers fished the Tellico as opposed to 1,891 on the Santeetlah. The total catch was 36,500 trout as opposed to 11,316 trout on the Santeetlah Creek Area. A creel census on the Tellico was accompanied by the stocking of 18,202 catchable-sized trout, all of which were fin-clipped. These fish made up 45 percent of the total catch, with a recovery figure up to a possible 90 percent. The stream-produced trout provided 55 percent of the catch. In this instance it is, of course, impossible to state what the catch might have been if no trout had been stocked, but it does not appear reasonable to expect a comparable harvest under the heavy fishing pressure without stocking. The percent of successful anglers in Tellico was 72 percent; on Little River, 66 percent. A summary of the Tellico data is included in the manuscript, "Management of Trout Fishing in the National Forests of the Southern Appalachians," to appear in volume 81 of the Transactions of the American Fisheries Society.

To sum up, I don't see how we can evaluate the effects of stocking unless we can recognize the fish that have been liberated, know something about the natural fish population, and give consideration to the fishing opportunities which the stream affords. Before accepting the authors' conclusion, "In a normal trout population, the addition of fish has relatively little effect on the rate of catch," I would like to see, first, the "normal trout population" reduced to the number of catchable-size fish per mile or per acre, and secondly, the limits of fishing pressure established within which this premise will hold. The stocking of catchable-size trout is a luxury which the economy-minded administrator would like to see justified if it is to remain an essential part of his program. The cooperative wildlife management areas in the southern Appalachians provide an exceptional outdoor laboratory in which to find out just what goes on in a trout stream, and to determine what stocking, if any, can be justified.

Willis King

"Copper sulphate is the best, least expensive, and least harmful algicide known at the present time. Its use as an algicide dates back over many years. During the summer of 1950, copper sulphate was applied to 23 lakes in Wisconsin. Research conducted in this state has shown that fish will not be killed in concentrations of copper sulphate normally used for algal control. Additional work has shown that the population of small animals associated with the algae is not harmfully affected.

"... The long-time effect of repeated copper sulphate treatments on the biological productivity of a water, and the possible deleterious effect of accumulated copper in the bottom muds upon bottom-dwelling organisms should be taken into account. Extensive creel census checks made on Minnesota lakes which have received copper sulphate treatment each year for 26 years indicate that continued treatment with copper sulphate has not seriously affected angling. Indeed, more fish were caught in the treated waters than in nearby lakes which have received no treatment."

--From "Cleaner Lakes Can Be a Reality," by K. M. Mackenthun, Wisconsin Conservation Bulletin, January 1952.

REPRINT

TRANSFER OF ANAESTHETIZED ADULT LAKE TROUT BY MEANS OF AIRCRAFT

Jean-Paul Cuerrier
Chief Limnologist, Canadian Wildlife Service, Ottawa, Canada

For stocking and restocking bodies of water, fish eggs, fry and fingerlings have been moved by a variety of means. Pack horses, packs on men's backs, railroad, steamship and aircraft have all been utilized. Aircraft, for example, have been extensively used in the Province of Quebec and in the states of New York and California. In the case of adult living fish, trucks and railroad cars equipped with water-filled tanks have been used most frequently as a means of transportation.

The Province of Manitoba transferred by air from Clearwater Lake to Cormorant Lake 1,100 and 1,000 adult lake trout in 1947 and 1948 respectively. These fish were moved over a distance of approximately 25 miles in Norseman and Husky aircraft equipped with water-filled tanks. These transfers necessitated 10 or 11 trips. An additional transfer of 1,000 adult lake trout was made in 1948 from Clearwater Lake to Manistikwan Lake; the distance between the two lakes is 50 air miles. (Information supplied by Mr. G. E. Butler, Department of Game and Fisheries, Province of Manitoba.)

Operation of 1951 Transfer

During the summer of 1951 a transfer of a large number of adult lake trout was carried out in Prince Albert Park, Saskatchewan, by the limnology section of the Canadian Wildlife Service. The background and the operation itself are discussed in this paper.

Investigations and reports indicated that an unbalanced population of lake trout, consisting of specimens weighing more than 10 pounds, was present in Crean Lake, Prince Albert National Park. As an attempt to re-establish a proper balance which would improve angling, it was recommended in 1949 that 400-500 adult lake trout, each of about five pounds in weight, should be released in Crean Lake. In Prince Albert Park, adult lake trout could be obtained only from Kingsmere Lake, or from Wassegam (Clearwater) Lake. There is no road connection with Crean Lake, so it was suggested that the fish be moved by aircraft.

An experiment was devised to investigate the possibility of moving fish anaesthetized and iced, rather than in water-filled tanks. This was based on the knowledge that fish can be kept alive when placed on ice under saturated oxygen conditions, that cold reduces the respiration rate of fish, and that anaesthetic drugs reduce the activity and oxygen consumption of these animals. This experiment was carried out at Jasper National Park during the summer of 1950 with the assistance of the hatchery superintendent, Mr. W. C. Cable. Seven eastern brook trout of approximately three pounds each in weight were anaesthetized in a two per cent solution of urethane, placed in a wooden box with chopped ice covering the fish, particularly the head region, and subjected to a 75-minute trip over paved and gravel roads. When they were returned to the hatchery, the fish were placed in a tank with running water. All seven recovered from this trip. It was then decided that the lake trout transfer scheduled for the following autumn could be made with anaesthetized fish packed in ice in a wooden container, thus permitting transfer of a maximum number of fish with the appropriation available for this project.

Wassegam Lake was selected for the capture of lake trout. This lake is located near the northeastern corner of Prince Albert National Park; it is practically inaccessible during summer and autumn except by air. According to Mr. Alex Pease, competent park guide who fished this lake commercially in 1928 and 1929 and accompanied anglers during recent years,

Reprint from The Canadian Fish Culturist (Issue 13), published at Ottawa, Canada, by the Department of Fisheries of Canada.

and according to surveys carried out in the autumn of 1950, Wassegam Lake was inhabited by a dense unexploited population of lake trout.

Plans were made during the summer of 1951. Operations began when a party of five, flown to Wassegam Lake, started extensive netting and angling for lake trout on September 17. Gill nets ranging from 1½-inch to 5½-inch stretched mesh were used.

At first the nets were visited, weather permitting, at frequent intervals throughout the entire 24-hour period. It was soon found that the largest catches of lake trout by gill nets were made between 6:00 p.m. and 12:00 p.m. The 1½-inch and 2-inch mesh nets were the most successful in catching lake trout in the excellent condition required for survival in reservoirs and retaining pots. Large mesh nets were abandoned after a few days because of the large number of fish that were being killed or seriously injured.

Nets Set in Shallow Water

The capture of lake trout by setting nets in shallow water, eight to 12 feet deep, was possible because these fish habitually feed in such depths in the latter part of September, when the spawning period is approaching. The lake trout caught ranged from one pound to 40 pounds (the latter being caught in a 1½-inch mesh net). Most of the fish seemed mature. The average weight of the fish released in Crean Lake is estimated at approximately five pounds, the greater number weighing between three and 10 pounds. Chicken-wire enclosures, wooden reservoirs, and retaining pots made of coarse twine were used to keep the lake trout alive. Because of wind and wave action, it was found that retaining pots were the most suitable. When the number of fish in captivity approached 500, a radio message requesting the plane for a definite date was sent to the park superintendent at Waskesiu.

A Norseman aircraft was chartered from the Saskatchewan Government Airways for the transfer. The entire operation may be described as follows:

Two canvas-fibre relay tanks were filled to a depth of about six inches with an aqueous solution containing 2-5 per cent urethane. The lake trout were then transferred with a dip-net from the retaining pots to a wooden reservoir near the shore. When required, they were caught by hand in the reservoir and placed in a galvanized wash-tub, in which they were carried quickly to a relay tank for anaesthetization. From 20 to 25 trout were treated in a relay tank at one time. Adequate anaesthetization required four to five minutes. When lake trout were anaesthetized, they were rapidly placed, one by one, in a wooden box and covered, particularly the heads, with layers of chopped ice. The box was then placed on the plane. In the meantime lake trout transferred to the other relay tank had become anaesthetized and were ready for packing and loading. The empty tank was filled with another group of fish after the solution had aerated. When the loading was completed, the plane was flown from Wassegam Lake to the south end of Crean Lake, an air distance of about 20 miles. At Crean Lake the plane was unloaded and the boxes were placed in shallow water. As each fish was transferred to a large wooden floating reservoir, the upper tip of the caudal fin was clipped. Some lake trout were also tagged with aluminum tags placed around the maxillary bone. When the fish in the reservoir started to swim, the off-shore end of the reservoir was sunk with a few rocks, so that the fish could leave freely. The time for recovery was found to be from 30 minutes to somewhat less than two hours. Most of the fish had escaped from the reservoir within one hour.

In spite of the wind and rough water, which were experienced when most of the transfers were being carried out, the average time required for a complete trip was approximately 75 minutes, measured from removal of the fish from the retaining pot at Wassegam Lake to the transfer to the reservoir at Crean Lake.

In seven flights, 1,231 adult lake trout were transferred from Wassegam Lake to Crean Lake. Of this number, 1,110 trout recovered and were released. Losses amounted to 10% of the fish moved. Total loss of fish caught in Wassegam Lake amounted to approximately 26 per cent, but this could be reduced, as result of experience, in any such operation in future.

On October 7 operations were brought to a close and the party and equipment were flown back to Waskesiu.

Acknowledgments

The author wishes to thank the Prince Albert National Park Superintendent for his interest in the project and his cooperation in planning and preparing the necessary material for the operations. Thanks are also extended to Messrs. H. Harrison, Alex Pease, T. Beale, J. Hiltz, and A. Boudreault, who took part in the operation. Special gratitude is due to Mr. Allen Hartley, pilot for the Saskatchewan Government Airways, for his cooperation in transferring the fish in the shortest time possible under the conditions that prevailed on these occasions.

ABSTRACTS

EFFECT OF REMOVAL OF STREAM-BANK VEGETATION UPON WATER YIELD

Earl G. Dunford and P. W. Fletcher
Transactions, American Geophysical Union, volume 28, number 1, pages 105-110. Feb. 1947

This is a preliminary report of results of a study wherein vegetation has been cut along the stream bank of a 22-acre watershed on the Coweeta Experimental Forest. Previous measurements on this forest have shown that complete removal of vegetation results in notable gains in water yield because of a reduction in transpiration. The cutting of riparian growth has also resulted in an increase in yield of sufficient magnitude to be significant in water-resource management.

Preliminary examination of the data immediately after cutting shows virtual elimination of the diurnal fluctuation during the growing season. This indicates that the vegetation immediately adjacent to the stream is making appreciable demands upon ground-water supplies contributing directly to the stream flow.

It can be concluded that important gains in water yield during the growing season in the southern Appalachian region may be realized with relatively little effort by eliminating the transpiration draft of riparian vegetation. This procedure can be of much practical value for municipal and industrial watersheds during drought years, when even small increases in yield are of unusual importance.

LAND USE AND TROUT STREAMS

Geoffrey E. Greene
Journal of Soil and Water Conservation volume 5, number 3, pages 125-26. July 1950

In many sections of the United States, formerly productive trout streams have been lost to production by changes in trout habitat brought about by logging, road construction, overgrazing, fire, and clearing land for agriculture.

For a period of a year, stream temperatures were measured from two mountain watersheds in the Coweeta Hydrologic Laboratory (U. S. Forest Service, Southeast Forest Experiment Station): one a typical farm, the other an undisturbed forest. The drainage area of the farm stream, originally supporting hardwood forest, had been under cultivation and pasturage for 8 years. The adjacent forested control watershed, supporting hardwoods, was similar in size and topographic features.

Weekly maximum temperatures of the farm stream ranged from 9° to 23° above those of the forest stream (see table). The maximum temperature for the farm stream ranged from 65° to 79°, whereas the temperature of the forest stream never exceeded 66°. August was the warmest month for the farm stream, whereas the forest stream was warmest in September.

This study reveals that shading is the key to control of stream temperatures, a condition that is further emphasized by the fact that the temperature of the farm stream dropped from 80° to 68° after it meandered through about 400 feet of forest and brush cover.

Because the absence of shade can exert such significant effects on stream temperature, it

Comparison of average monthly stream temperatures, forest and farm streams

Season	Maximum			Minimum		
	Forest	Farm	Diff.1/	Forest	Farm	Diff.1/
Winter						
Dec.	48.5	51.0	+ 2.5	43.8	43.5	- 0.3
Jan.	51.7	52.5	+ 0.8	45.7	42.8	- 2.9
Feb.	46.5	49.2	+ 2.7	38.0	36.7	- 1.3
Mar.	48.5	53.2	+ 4.7	41.2	38.2	- 3.0
Spring						
Apr.	55.8	63.0	+ 7.2	46.8	43.2	- 3.6
May	56.8	69.8	+13.0	52.5	51.6	- 0.9
Summer						
June	61.5	71.7	+10.2	55.0	57.2	+ 2.2
July	61.5	73.8	+12.3	57.3	59.5	+ 2.2
Aug.	64.2	75.8	+11.6	61.0	63.0	+ 2.0
Sept.	65.0	74.8	+ 9.8	59.7	1.8	+ 2.1
Fall						
Oct.	59.0	65.1	+ 6.1	53.0	54.0	+ 1.0
Nov.	53.2	57.3	+ 4.1	48.0	48.0	-

1/ Represents change caused by mountain agriculture.

is evident that careful manipulation of riparian vegetation can be a means of maintaining optimum temperatures necessary for the growth and development of trout and the aquatic organisms on which they feed. The control of stream temperatures through watershed management should be given more consideration in future land use programs.

AMERICAN FISHERIES SOCIETY

Through the courtesy of Dr. Ralph Hile, president of the American Fisheries Society, we have been permitted to publish the following abstracts of papers that were presented at the 82d Annual Meeting of the American Fisheries Society:

EFFECTIVENESS OF ROTENONE IN POND RECLAMATION[1/]

Howard P. Clemens
University of Oklahoma
Norman, Oklahoma
and
Mayo Martin
Oklahoma Game and Fish Department
Chickasha, Oklahoma

The use of rotenone as a means of eradicating fish was studied in about 30 ponds distributed throughout Oklahoma and representing various summer conditions in 1951. In addition, 1 pond was investigated during the winter.

Over 90 percent of the ponds were thermally stratified, and rotenone did not penetrate to the bottom of these shallow ponds (6 to 13 feet). Agitation with an outboard motor was effective in increasing the penetration of the rotenone. Subsequent to its application, the lower concentrations of rotenone were found in the waters nearest the bottom, and the higher concentrations in the surface waters. This was probably due to a minimum of mixing of the subsurface waters resulting in an increase of density with depth, and perhaps to greater dissipating power of the lower levels of these chemically stratified ponds. Rotenone in clear waters of low alkalinity (16 p.p.m.) became detoxified in 3 to 6 days depending on the concentration used, while in clear ponds of high alkalinity (60 to 284 p.p.m.) detoxification occurred in 1 to 3 days when similar concentrations were used. In turbid waters of high alkalinity, dissipation took from 1 to 2 days longer. Dissipation in a clear-water pond of high alkalinity during the winter took from 9 to 10 days. Dissipation occurred from the bottom toward the top. Completeness of the kills was evaluated for 2 to 3 days after treatment. Two to three months following application, 19 ponds were re-evaluated. Of these, 15 contained fish; and, in all but 1, only young-of-the-year were collected.

[1/] A study conducted by the Summer Survey of the Oklahoma Game and Fish Department in 1951.

RETURNS FROM PLANTINGS OF LEGAL-SIZED BROOK, BROWN, AND RAINBOW TROUT IN THE PIGEON RIVER, OTSEGO COUNTY, MICHIGAN

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Michigan Department of Conservation
Vanderbilt, Michigan

A complete census of fishing on 4.8 miles of the Pigeon River, together with population estimates made at the end of the open season, made possible an accurate evaluation of the yield and survival of open-season plantings of hatchery trout. Fishing intensity in this research area for 3 years averaged 2,414 daily trips per year, a number equivalent to 278 hours of fishing effort per acre per year. Sections in which hatchery fish were planted attracted about three times as much fishing as did the unplanted sections.

Fishing quality, measured by the catch per hour per fishing trip, was generally poor for native fish, averaging less than 1 fish for 5 hours of effort. Hatchery fish made up about 70 percent of the total catch for the 3 years.

Planting a few trout at a time from a live-crate (scatter planting) did not prove to be more advantageous than liberating large numbers of fish in one hole (spot planting). Trout that had been "scatter-planted" did not contribute to the catch for a longer period of time and they resulted in fewer successful fishing trips, fewer total fish returned to anglers, and slightly fewer anglers sharing

in the total catch. However, the practice of making several plantings on different dates, a few fish at a time, proved to be successful in permitting more individual anglers to share in the catch.

Although 4,500 legal-sized trout were planted each year, about half of the fishing trips were unsuccessful. Limiting the daily catch to 5 trout, instead of 15, did very little to reduce the percentage of unsuccessful anglers. Further reduction to 2 fish per day lowered the unsuccessful fishing trips to 36 percent.

Plantings of rainbow trout and brook trout gave much higher returns to the fishermen than did equal numbers of brown trout. Rainbow trout also survived overwinter as well as did brown trout, although in both species the survival was less than 10 percent. Overwinter survival of brook trout was less than 3 percent. Fin-clipped trout were recovered by fishermen more readily than those which were jaw-tagged, especially during the first week after planting.

Rainbow trout and brook trout, planted when water temperatures were below 50° F., exhibited an immediate downstream movement; the majority of the recoveries were taken several miles below the planting site. Fish of plantings made when water temperatures were above 50° F. showed very little movement; the majority of the fish were recovered within 1 mile of the planting site.

Legal-sized brook, brown, and rainbow trout, planted in a stream subjected to heavy fishing pressure, contributed to the catch for a relatively short time. Brook trout were exploited most readily; only 4 percent of the recoveries were taken after 40 days of liberty. For brown trout and rainbow trout, these values were 26 percent and 22 percent, respectively. All of the plantings suffered a considerable unexplained loss. This loss was greatest when poor conditions for exploitation by anglers prevailed over the initial 20 to 40 days after planting.

Planting large numbers of hatchery fish (as many as 431 trout per mile) apparently had no effect upon the catch of wild fish in the stream. Although the catch per hour of the planted trout increased greatly at the time of planting, the corresponding weekly catch-per-hour data for the wild trout showed no similar rise.

Spinners plus worms, and worms, generally were more effective in catching trout in the Pigeon River than were flies or miscellaneous baits. However, this success was due almost entirely to the predominance of hatchery trout taken by persons using worms, or spinners plus worms, and was in spite of the marked superiority of flies or fly fishermen in catching wild trout.

THE MOVEMENT AND RECOVERY OF TAGGED LAKE TROUT IN LAKE SUPERIOR, 1950-52

Paul H. Eschmeyer, U. S. Fish and Wildlife Service, Ann Arbor, Michigan

Russell Daly, Wisconsin Conservation Department, Bayfield, Wisconsin

and

Leo F. Erkkila, U. S. Fish and Wildlife Service, Marquette, Michigan

A total of 733 native lake trout was tagged at two widely separated localities in Lake Superior, with a subsequent recapture of 155 fish (21.1 percent) during the year after marking. In October 1950, 116 large lake trout (average total length, 27.3 inches) were tagged near Keweenaw Point, Michigan. Fifteen (12.9 percent) were recovered during the first year at points as far west as the Gooseberry River, Minnesota (190 miles), north to the Slate Islands, Ontario (95 miles), and east to Grand Marais, Michigan (100 miles). Only 7 recaptures were made within 50 miles from the locality of release. Nine fish (7.8 percent) were recovered during the second year after marking. Returns from 617 tagged lake trout of smaller size (average length, 18.2 inches) released in the Apostle Island region of Wisconsin during the period June 12 to August 2, 1951, numbered 140 (22.7 percent) during the first year. Of these fish, 90 percent were recaptured within a radius of 50 miles from the points of release. Seventy-six percent were caught in Wisconsin waters, 14 percent in Minnesota, and 9 percent in Michigan waters of Lake Superior. The fish retaken in Michigan had moved 120 to 255 miles between the time of release and recapture, traveling as far east as Grand Marais. Lake trout recaptured at distances of more than 50 miles from each of the tagging localities were of larger average size than marked fish caught within this radius. Four types of tags used in the marking of lake trout in the Apostle Island region, together with the number tagged and percentage recovered during the first year, were as follows: 103 aluminum lower-jaw tags (used only on fish less than 17 inches in length when marked), 10.7 percent; 200 monel upper-jaw tags, 14.0 percent; 162 streamer tags, 19.8 percent; and 152 Petersen tags, 45.4 percent. Obviously, lake trout

marked with the Petersen tag, with the discs and ends of the pin projecting from each side near the point of maximum girth, were more vulnerable to the fishery than were those fish marked with other tags. The recoveries of marked fish show that Lake Superior lake trout--particularly fish of large size--may move many miles and freely cross political boundaries, and that the rate of harvest is moderately high for a fish with a life history as long as that of the lake trout.

THE INCREASE IN GAME-FISH POPULATIONS IN EAST OKOBOJI LAKE, IOWA, FOLLOWING INTENSIVE REMOVAL OF ROUGH-FISH

Earl T. Rose and Tom Moen
Iowa State Conservation Commission
Des Moines, Iowa

Test seining in East Okoboji Lake, Dickinson County, Iowa, in 1940 revealed a large population of rough fish and relatively few game fish. The Iowa Conservation Commission therefore intensified its rough-fish removal activities on the lake. After several years of this expanded program, significant increases of game fish occurred. These increases are reported in the form of comparative data on the catch-per-unit effort over a period of 12 years, from 1940 to 1951. General observations indicated an improved environment for game fish and an increase in angling success.

MOVEMENT OF PARASITIC-PHASE SEA LAMPREYS IN LAKES HURON AND MICHIGAN

Bernard R. Smith and Oliver R. Elliott
U. S. Fish and Wildlife Service
Rogers City, Michigan

A program of tagging was carried out in the waters of northern Lake Huron during the fall and winter of 1951-52 in order to supplement the small amount of information available on the movement of sea lampreys during their parasitic phase. A total of 219 parasitic-phase sea lampreys was tagged and released at three localities. Of this number, 38 (17.2 percent) were recovered. One tag was recovered near North Manitou Island, Lake Michigan. The remaining 37 were taken in Lake Huron or in streams tributary to that lake. The dispersal of tagged lampreys throughout Lake Huron was wide. Five marked individuals were taken in the southern part of the lake, more than 150 miles from the point of tagging; four of these five were captured in Canadian waters. The marked lampreys exhibited no distinct pattern of migration other than a tendency toward a general southeasterly movement in Lake Huron.

A MORE COMPREHENSIVE DESCRIPTION OF BACTERIUM SALMONICIDA

Philip J. Griffin, S. F. Snieszko, and S. B. Friddle
U. S. Fish and Wildlife Service
Microbiological Laboratory
Leetown (p.o., Kearneysville), West Virginia

The purpose of this study was to establish a set of descriptive data which could be used as a reference or a standard in the identification of Bacterium salmonicida, the cause of furunculosis in fish. Since a complete description of B. salmonicida was not available, bacteriologists were not in a position to identify this microorganism in a manner which would meet the rigorous requirements of present-day bacteriology.

Ten strains of B. salmonicida were employed in these studies. There is presented a detailed description which includes the morphological, cultural, and physiological characteristics of B. salmonicida. In addition, various factors such as oxygen, pH, temperature, and media composition are discussed in terms of their influence on the formation of the melaninlike pigment which is characteristically produced by this microorganism.

TECHNIQUE FOR THE APPLICATION OF A STREAMER-TYPE FISH TAG

Leonard S. Joeris
U. S. Fish and Wildlife Service
Sturgeon Bay, Wisconsin

Principal features of the technique are: attachment of the plastic tag by means of a nylon-thread loop prepared in advance of field work; use of a curved surgical needle with cutting edge and a split eye for application of the tag. The procedures for splitting the needle's eye and for applying the tag are described and illustrated by a series of photographs.

THE FOOD AND GROWTH RATE OF YOUNG WHITE BASS, MORONE CHRYSOPS, IN LAKE TEXOMA

Edward W. Bonn
Texas Game and Fish Commission
Denison, Texas

A study of the food and growth rate of the young white bass (Morone chrysops) was made from specimens collected between June and October, 1950 and 1951, in Lake Texoma, Texas. The major food organisms eaten by 125 young white bass in 1950 and 168 bass in 1951 were crustaceans (chiefly Cladocera and Copepoda), insects (chiefly Chironomidae), and gizzard shad. White bass ranging from 23 to 125 millimeters in standard length ate all three types of organisms during the 5-month periods. Shad made up the largest percentage of volume of food eaten. Measurements from 349 young white bass in 1950 and 380 young bass in 1951 showed that the 1951 fish grew much faster than those in 1950. The average standard length at the end of October 1950, was 74 millimeters; whereas for the same period in 1951, it was 126 millimeters. The accelerated growth of the 1951 white bass was due to the prolonged high water level in the spring of that year and to their continued heavy diet of fish.

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